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A WORK FOR THE PRACTISING PHYSICIAN

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IN FIVE VOLUMES

*Illustrated by 90 full-page plates in colors and black and white and by 627 other
illustrations, of which 54 are in color.*

VOL. V.

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Preface

THE present volume is intended as a guide for the general practitioner in surgical cases in children, especially those on the borderland where treatment leaves the domain of internal medicine and enters that of surgery or orthopædics.

It is from this point of view that the contents of the book should be judged. It is not intended to give an exhaustive description of the various pathological types, nor the details of pathological changes, nor a minute presentation of the surgical technique. The task assigned us by the editors was to present a brief and concise survey of those conditions in which surgical or orthopædic interference may become necessary on the part of the practitioner.

The lines of surgical treatment are sketched out briefly, so that the physician may have a complete résumé of the methods in use.

The methods which have been specially tested and approved by the authors and extensively used with their patients in the surgico-orthopædic department of the K. K. Kinderklinik at Gratz (Austria) and the Royal Policlinic for Orthopædic Surgery at Munich (Germany) will receive a more detailed and prominent explanation Our experience is based on this material, and the methods we have thoroughly tested and applied are recommended to the practitioner. Short case histories which have been interspersed may tend to impart to the work a more vivid interest. We have also endeavored to do justice to methods employed by others, the original works being cited for reference.

As it is easier and quicker to obtain a working knowledge from an illustration than from the most graphic description, care has been taken to provide abundant illustrations, for the careful execution of which the publishers deserve our thanks. With a few exceptions these illustrations are original and represent cases from our hospitals.

The subject-matter has been arranged as far as possible in etiological groups; this renders possible a concise and clear presentation; some difficult topics, however, had to be discussed in appendices to related subjects.

While the French literature commands a series of brilliant authors—Kirmisson, Broca, Piéchaud, Froehlich—in the domain of the surgery of childhood, there have been no detailed publications in Germany since F. Karewski's "Die Chirurgischen Krankheiten des Kindesalters," Stuttgart, 1891.

We believe the publication of this supplementary volume supplies a real need and trust that its purpose of serving the medical practitioner may be fulfilled.

F. LANGE.   H. SPITZY.

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VOLUME V.

THE DISEASES OF CHILDREN

GENERAL CONSIDERATIONS

BY

HANS SPITZY, M.D., Gratz

I. THE CHILD AND SURGERY

THE surgery of childhood stands in the same relation to general surgery that infantile therapeutics bears to internal medicine. Old methods and traditions connect them, and the great strides of the last few decades permit of extending operative procedures to the tender tissues of the infantile organism which had formerly been regarded as inaccessible to major interference.

The difference is not only quantitative in that the smaller local proportions render the work more difficult, but the response of the infantile organism both to the irritation of disease and especially to that of operative interference is totally different from that of the adult. The operative possibilities in the child are subject to different factors: On the one hand considerable interference is well tolerated under certain conditions; indeed, the healing tendency is generally better than in the adult; while on the other hand minor interference often affects the tender organism so profoundly that the shock is overcome only with difficulty. I need only refer to anæsthesia and peritoneal operations.

Besides, in childhood there are other factors, partly known and partly unknown, which often play an ominous rôle and demand the greatest caution: shock and the status lymphaticus are dreaded spectres, the nature of which is but little understood; rachitis demands attention, especially in its complex relations to normal and abnormal growth. Injuries and infections, their onset, their pathological changes, and their treatment, differ considerably from the analogous processes of the adult organism.

Disturbances of the embryonal mechanism of development and derangements of postnatal growth dominate the domain of infantile surgery. Congenital deformities and affections of the apparatus of locomotion, which generally belong to the field of orthopædics, are most frequent. In France this fact finds expression in the establishment of a

specialty under the name of "La Chirurgie Infantile"—a happy union between infantile surgery and orthopædics which supplies a practical want and will be duly considered in the present volume.

In order not to exceed our narrow space limits, the greater importance has been placed upon congenital deformities and disorders of locomotion. Certain conditions have been described which demand special consideration in childhood, such as treatment of hernia, tuberculosis of the joints in its various forms, fractures in early childhood, treatment of paralysis, appendicitis, intussusception, and rectal prolapse, while other subjects, such as tumors, are only superficially treated on account of their slighter importance, and only their more prominent points are discussed.

In those pathological conditions whose clinical treatment has been fully described in other volumes of this work, only the surgical aspects with their special diagnosis and indications have been taken into consideration, and reference has been made to the chapters dealing with the clinical aspect.

II. OPERATIONS IN CHILDREN

"The child is too young and weak for operation, bring it again in a few years." Parents are frequently put off with these words when they bring a child to the physician with a congenital or incipient deformity.

The questions to be considered are whether the child's organism is able to withstand an operation or is our technic unable to adapt itself to all conditions in childhood?

It seems that the latter is the case, for it is often more necessary to operate early in the case of the child than in the adult.

A serious injustice may be done to the child by deferring an operation. A deformity in its primary condition often can be easily corrected, while at a later stage it may be accompanied by so many secondary deviations that it is very difficult to restore the normal state. The coefficient of growth in early childhood in the normal body is as great as the coefficient of deformity.

Anomalies which cannot be corrected in their early stages may interfere with the growth and well-being of the child and stand in the way of its physical development. The great psychic factor which the constant ailing and the anxious guarding entail upon the growing generation, even in our best social circles, is also to be considered. How, then, do the lower social strata fare? Smaller earning capacity and increased misery of family conditions throw their shadow upon coming generations.

The child's organism meets us half way. This is the time of rapid development, when Nature tries with all her might to bring the body

to maturity for the "preservation of the species." After that, her interest in the individual appears to diminish considerably.

The ability to preserve and direct the impetus to growth and regeneration is not so great in later life as during the period of childhood. We may profit by these facts and count upon the aid of Nature much more in the child than in the adult. We need not work with so large an "assurance," for it is frequently sufficient to remove an obstacle and the budding organism does the rest, while in later life Nature frequently disappoints us. For example, we can dispense with complicated muscle closure in hernia operations, and in the case of fractures union takes place more rapidly. Operative procedures in childhood can, therefore, be simplified. An important axiom in the surgery of childhood is that the extent of the operation must be proportioned to the vital energy of the child. This would be but a hollow phrase had not clinical and operative experience taught us certain fundamental rules which we recommend should be adopted in practice:

1. No operation should be performed on a newborn infant unless his weight is over 3000 Gm. (6 lbs.). (Of course, this does not apply in a question of life and death.)

The weight is a reliable index of vital energy in the newborn. The normal birth weight is 3000 Gm. (6 lbs.); below this weight there is a certain vital deficiency which is greater the older the feeble infant. (See Harelip, Hernia.)

In older infants the question of operation should be decided with due regard to the other factors of bodily nutrition. If possible, the operation should be deferred until the baby is better nourished.

2. Never operate when the child is losing in weight. Observation of this rule will prevent many deaths of "intercurrent disturbances of nutrition." A few days' observation are sufficient to reach a conclusion.

3. The operation should be as simple as possible so that it can be done in the shortest possible time. Complicated plastic operations should be avoided. Several small operations will be better tolerated by the child than one long operation, even if executed with brilliant skill and technic.

4. Work as rapidly as surgical thoroughness and care will admit. Minutes may be decisive. The child's heart is relatively a better organ than that of the adult as it is not yet toxic and overworked, but it cannot bear as much, and if the cardiac depression has once occurred the heart rallies with difficulty.

Operations lasting for more than a quarter of an hour seldom terminate favorably.

5. Operations which require much exposure of vital organs and tissues, even if of short duration, are badly borne. This refers chiefly to a large opening of the abdominal cavity. Intestinal operations, which

are practically done extraperitoneally by pulling the intestine through a narrow abdominal incision, are borne well by the youngest infant.

The young child cannot stand a great loss of blood, but a slight loss is more easily overcome.

6. Surgical cleanliness of the hands and of the operating field are requirements that are self-evident.

After mechanically cleansing the hands with sand soap they should be washed with liquid green soap for 5 minutes and dried with a sterile towel. The soap is then removed in one-tenth per cent. solution of benzin iodide and the hands are rinsed with a one per cent. bichloride solution. The hands are dried before the operation and anointed with sterile oil, in order to protect them from fissures and in order to have a separating layer between the hand and the field of operation. Gloves may be put on and direct contact with the wound avoided. In the case of infected wounds, rubber gloves should always be used.

The field of operation is cleansed in the usual way and covered with a bichloride dressing for 12 hours before operation. This is removed immediately before the operation with a benzin-iodide solution, painted with tincture of iodine, and finally the entire region of operation is covered with a colloid solution.[1] This resinous layer has considerable advantages. It occludes the skin, the pores of which are difficult to cleanse, and if any germs should still be present or fall upon it, they will be fixed in the colloid layer which contains no nutritive substance, and are at least prevented from multiplying or spreading. Moreover, the towels placed over it remain upon the skin without slipping off, which is a matter of considerable importance in restless children whose anæsthesia is not profound.

The wound and sutures should be painted again with the same colloid mixture after the operation. Stitch abscesses are rare, especially the superficial ones, when this method is adopted. Another advantage is that the bandages cannot be shifted. This is a matter of importance in a child, moreover, as not as many bandages are required.

7. Care should be taken not to let the child grow cold during the operation (see Anæsthesia).

8. Preparations should be made beforehand for surgical emergencies. The after-treatment is important in these cases. Transfusions and enemas of normal salt solution rapidly raise the blood-pressure which will have sunk in the event of considerable loss of blood. In artificially fed children the milk should be somewhat reduced in composition during the first few days, but should be rapidly restored to normal. If breast-fed, the nursing should of course be continued, as this decidedly improves the prognosis.

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[1] Colophon, 50.00, mastich, 25.00, alcohol 95%, 360.00, terebinth, 30.0, res. alb., 15.00.

9. The bandages must be arranged to provide for the passage of urine and stools. Small bandages fixed with colloid and adhesive plaster fit more snugly and can be more easily controlled than thick dressings of wadding and gauze.

With these limitations and precautions the statistics of operations on the child do not show worse results than on the adult. They are frequently better and there is less danger of relapse.

The advantages incidental to early operation on the infant can be secured by bearing in mind the fact that a child is not a miniature adult, but a budding, growing organism, embodying many physiological laws of its own, the knowledge of which has to determine the plan of operation.

III. ANÆSTHESIA IN CHILDREN

General anæsthesia is necessary in order to perform major and delicate minor operations. It is often necessary in the case of children to deaden not only pain but also consciousness in order to secure the quiet repose necessary for the operation, whereas the same operation in adults could be performed under local anæsthesia.

Chloroform and ether are both poisons and the dangers of placing the child under their influence should be appreciated. Ether, however, is more benign, and as larger quantities of it can be used, it is possible to control the narcosis more closely. A few grammes of chloroform are sufficient to anæsthetize a child, while more than twice the quantity of ether is required for the same purpose. This alone is a reason why ether is better suited for children who, as a rule, yield easily to its effect.

Chloroform is a pronounced cardiac poison, and although the child's heart is strong, it is peculiarly susceptible to poison. The number of deaths is considerably larger under chloroform than under ether (5 : 1).

Ether has the bad reputation of exerting a particularly baneful influence upon the organs of respiration and has been accused of causing bronchitis and pneumonia, but this depends largely upon the method of administration and the selection of the cases.

A comparison of children immediately after chloroform and after ether anæsthesia will at once decide the question in favor of the latter.

The chloroformed child looks pale, the cardiac function is visibly altered, the pulse is small, and the appearance of the patient causes anxiety. The etherized child is red, the pulse is large and full, and the sleep resembles natural conditions.

Based upon the experience of more than 1000 anæsthesias in children, I believe that ether anæsthesia is preferable in childhood, especially in the form it has been practised in America for a long time and which is known as ether intoxication or the drop method.

As many text-books still recommend light chloroform anæsthesia in children, I will describe the method of anæsthetizing as is exclusively used by us for the last eight years.

The most important point is that the smallest possible quantity of ether should be used.

The simplest and most convenient mask is the cuff mask which is generally used in America (Fig. 1).

A rectangular piece of stiff paper is rolled up with a small towel, the overlapping edges of which are turned inward at both ends and folded

FIG. 1.

Ether anæsthesia as practised in the surgical department of the Pediatric Clinic in Gratz. *a*, towel with stiffening paper (*b*) attached; *c*, lateral view of the rolled-up cuff; *d*, upper view, the overlapping margins of the cuff are turned inward; *e*, method of application (drop method, eye protection, face left free by mask).

up inside the tube which receives the ether. This mask can be made rapidly anywhere and of any desired size. It is easily sterilized and, what is its greatest advantage, it covers only the mouth and nose, leaving the rest of the face free (Fig. 1, *e*).

A few drops of ether are allowed to drop on one end of the cuff mask and the other end is placed near the child's nose and mouth. The respiratory air and the ether vapor become slowly mixed by the time the cuff is over the nose and mouth. If air hunger sets in (recognizable by oppressed breathing) the mask is raised and a few breaths of air are admitted, after which it is again slowly placed over the mouth and the analgesic condition known as ether intoxication soon appears.

The child should be kept in this state between sleep and waking. Deep anæsthesia, which is easily attained by adding a few more drops of ether, is only necessary when operating on the peritoneum or the

tonsils. All other operations can be carried out in the intermediary stage without danger.

The cuff is removed before the operation is completed, the after-sleep being still painless or at least accompanied by diminished sensation. As soon as the last suture is tied the child should be awake, unless the dressings are painful.

If the child is still under the influence of the anæsthetic after the operation, the anæsthetist has either not been watchful or has allowed himself to give too much ether under the influence of the operator's impatience.

It is unquestionably possible to avoid the unpleasant after-effects of ether upon the respiratory tract by observing precision in dosage.

Vomiting and nausea are extremely rare and seldom last more than a few hours. Generally children tolerate fluid food a few hours after the operation, unless there are pains that deprive them of their appetite.

Children should be protected from becoming cold during anæsthesia, and only the necessary parts of their body should be exposed. The temperature of the operating room should not be below 24° C. (75.2° F.). Warm coverings should be applied after the operation to compensate for the loss of body heat during the operation.

It should never be forgotten that a child's body is more rapidly cooled than that of the adult (catching cold).

The air in the sick room should be frequently renewed as long as the child's breath smells of ether.

If anæsthesia is carried out in this manner, there should be no unpleasant results. I have never seen arrest of respiration, with following artificial respiration and its accompanying exciting scenes and great imperilling of asepsis, since the exclusive use of ether, while in chloroform anæsthesia this was no unusual occurrence. Slight rise of temperature on the day of operation, attributable to bronchitis, has occasionally been observed, but we have never lost a life, while deaths not infrequently occur from the condition of collapse incidental to chloroform anæsthesia.

One single exception should be made in the case of older children with cleft palate, who are kept quiet under ether only with difficulty. Here anæsthesia, after having been commenced with ether, may be deepened by a few drops of chloroform.

Lumbar anæsthesia, in spite of the easier execution of lumbar puncture in children, should never be employed.

Local anæsthesia becomes more important the older the child and the more it is possible to count upon his intelligence.

Ethyl chloride and infiltration by the Schleich and other methods may be used in many conditions (resection of ribs, struma, skin opera-

tions), but due regard must always be paid to the tenderness of the skin (skin necrosis in the newborn after using kélène).

I use the one-half to one per cent. novocaine solution proposed by Bier, which I prefer to the other solutions on account of its greater simplicity.

Conduction anæsthesia by interrupting the nerve conduction, following Braun, especially when combined with a few drops of one per cent. adrenalin solution, admits of extended application of local anæsthesia which renders excellent service especially in operations on the extremities and in plastic skin operations.

SECTION I

CONGENITAL AFFECTIONS

(See Knöpfelmacher, Diseases of the Newborn, vol. i.)

BY

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TRANSLATED BY

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A. CONGENITAL DEFORMITIES OF THE BRAIN AND SPINAL CORD

(See Zappert, Organic Diseases of the Nervous System, vol. iv.)

THE severest abnormalities among the congenital affections of the central nervous system do not permit of surgical interference. Acephaly, anencephaly, and severe clefts of the cranium are inoperable.

The most frequent defects of development are those which accompany partial clefts of the cranium and vertebral column and which are known by the names of cephalocele and spina bifida. Both are instances of arrested development originating in the first few weeks of embryonic existence.

The earliest deformities date from the time the medullary tube lay openly exposed. Later deformities occurred when the closed medullary tube, with its end dilated, protruded through unclosed bone spaces.

It is necessary to trace the beginning of these disturbances of development so that existing variable conditions can be intelligently explained.

I. CEPHALOCELE

(Congenital cerebral hernia.)

At certain favorite places greater or smaller defects of the cranium are formed through which its contents protrude. The contents of the hernial sac may vary, and accordingly cephalocele can be divided into the following groups:

1. **Encephalocystocele.**—Here a small portion of the cerebral sac has prolapsed through the opening in the skull. The wall consists of cerebral masses and their covering meninges.

2. **Meningocele.**—The wall consists *only* of the internal cerebral meninges; parts of the brain substance itself are not demonstrable in the wall of the sac, although there may be some contained within the sac.

The **etiology** is readily understood from the preceding explanation, so far as these still obscure biological processes are within our knowl-

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edge. Questions as to why there should be a prolapse or why the cranium should remain open at some places are still unanswered. To say that intra-uterine inflammatory processes, amniotic cords, excessive fluid pressure in the interior of the sac, are responsible is only a makeshift. They may be a contributory factor, but how much of it is due to degenerative processes, family heredity, inferiority and disease of the parents, and whether the entire chain of deformity is not a normal reaction, are questions for future investigators to elucidate. The investigations of Hönike, Hertwig and others throw some light upon these points. These investigators were able to produce entirely analogous deformities on lower animals by impairing the health of the parental pair before procreation by chronic poisoning and by injuring the ovum.

Fig. 2.

Anterior nasofrontal encephalocystocele. Child eight weeks old. The cystic enlargement communicates with the interior of the skull (tumour erectile).

The origin of these deformities is best explained by the opinion advanced by von Bergmann, who assumes — as do Recklinghausen and Morian—that in every case there is a misturning of the cerebral sac. All other formations, including meningocele, are of secondary origin. In meningocele the sac has undergone excessive thinning. The cerebral substance has been obliterated or not developed, or it has receded into the interior of the skull cavity during growth. The fine ependyma which lines the inside of the sac points to this origin. All these cysts communicate with the interior of the ventricle. The ducts may be traced through the pedicle with very fine probes, but they sometimes become entirely obliterated (Fig. 4).

This explanation is simple and logical, although there are various possible combinations of deformities which seem to throw doubt on the clearness and justification of the assumption.

Pathological Anatomy.—The protrusion has a predilection for certain regions of the cranium. Accordingly, we distinguish cephalocele which emanates from the facial skull, usually at the root of the nose, as anterior cephalocele (Fig. 2), and cephalocele which emanates at the occiput above the foramen magnum as occipital cephalocele (Figs. 3 and 4).

Basal cephalocele, situated at the base of the skull, is much rarer, though possibly it is observed less frequently on account of its small size, as it might be taken for a pharyngeal cyst.

Anterior cephalocele is subdivided into *nasofrontal*, protruding above the nasal bone; *naso-orbital*, protruding in the inner canthus; and *naso-ethmoidal*, appearing below the nasal bone. Occipital cephalocele is called superior or inferior according to whether it appears above or below the occipital protuberance.

Fig. 3.

Superior occipital encephalocystocele. Child one week old. The protrusion contained the cystically distended cerebellum.

There are other places in the skull where occasionally gaps may occur with prolapse of the meninges or cerebral substance, as for instance at the orbital margin or at the sutures.

The gap is generally round with sharp borders and the dura merges into the periosteum of the external skull. Only the inner meninges, the arachnoid, and the pia accompany the cerebral protrusion. Frequently they are closely adherent to the external covering membrane at the top of the excrescence. The thinning and blending of the meninges and periosteum are dependent upon the pressure exerted on the covering

tissues by the interior fluid. The tension of the fluid frequently changes, so that many of these cystic tumors look as if they were ready to burst, especially when there is a considerable accumulation of fluid in the brain (see Fig. 2).

It is possible to draw conclusions as to the size of the communicating duct and the pressure conditions present in the interior of the skull from the difference in tension. This is a matter of importance in deciding upon the possibility of operation.

Fig. 4.

Inferior occipital meningocele. Child four weeks old. The protrusion contained no cerebral parts and no communication with the interior of the skull.

This refers principally to anterior cephalocele; the occipital form differs in this respect, inasmuch as it is more frequently present as a meningocele (Fig. 4). That smaller herniæ are more frequent and rarely contain brain substance is perhaps due to the fact that they emanate from the fourth ventricle with its thin covering. In the large tumors, which almost attain to the size of the rest of the skull and are broadly sessile, large parts of the primitive cerebral sac are frequently prolapsed (see Fig. 3).

The **symptoms** of these tumors are so distinct that they can hardly be mistaken. It is of clinical importance to know that these cerebral herniæ, as long as they remain closed and do not approach a fissure of the cranium, often cause little disturbance in the condition of the child for a long time.

The **bimanual examination**—pressing upon the cyst and upon the fontanelle—gives information as to the size of the cyst. In this connection the variations of the pulse and respiration pressure, which parallel those of the fontanelles, are of importance. When the tension is low the firmer parts of the contents as well as the size of the bony defects can be felt. A portion of the fluid can be pushed back by pressure upon the tumor, while the palpating finger of the other hand can feel the rising pressure of the fontanelles.

If these latter symptoms are absent, the conclusion is justified that the communication with the cerebral cavity is only slight or obliterated. This, together with the absence of firm parts and transparency of the tumor, points to meningocele.

The **diagnosis** may therefore not be difficult. The position of the tumor, the variations of its pulse pressure, the possibility of partly squeezing it out, the results of palpation and its location, distinguish it materially from any other tumor. A closed meningocele might be mistaken for a cystic tumor of the cranium, which, however, would not make any practical difference. These tumors are not of infrequent occurrence.

The **prognosis** of these malformations varies according to the extent in each case. As a general rule they have a great tendency to enlarge. The tension and thinning of the walls involve the danger of bursting and infection, quite aside from the increasing disfigurement.

The **treatment** can, in the light of our present knowledge, only be surgical, and consists in the removal of the hernial sac after its contents have been replaced.

An ear-shaped incision is made around the pedicle, so that skin suture will not lie over hernial suture. The pedicle is then exposed and the hernial sac is opened. After rapid inspection and reposition as far as possible of the protruding parts the hernial sac is closed. Very few punctures should be made. If the pedicle is thin enough to be ligated and invaginated, this is preferable to any suture, because every needle puncture which pierces the inner surface is a canal for the exudation of the cerebrospinal fluid. This interferes with the healing of the wound and at the same time forms an open door for infection, which in any case can only be avoided with difficulty. The closure of the osseous defect is done by the osteoplastic method. Osseous or cartilaginous tissue can be made to grow into the gap by means of grafts either from the same or from another bone, and later these can be used in conjunction

with the nutrient skin flap for covering the defect. The following example may illustrate this:

An eight-weeks-old child (Fig. 2) was admitted with an anterior nasofrontal encephalocystocele. There was a gap at the base of the nose measuring 2 cm. in diameter, above which was a multiple vascular tumor. Many small fibromas and cysts were attached to this tumor which were produced by disseminated remnants of blastoderms and pointed to the origin of development. The tumor was partly reducible and soft masses could be felt by palpation. As a preliminary operation the anterior half of the patella (which in the child is cartilaginous except for the osseous nucleus) of about the size of the osseous defect was removed and inserted, the freshened side outward, through a slit underneath the skin of the frontal bone in the neighborhood of the tumor.

The cartilage healed in smoothly. After three weeks the tumor was rapidly removed, turned inward and sewn over. During the operation there was an occasional arrest of respiration, as has been observed by other authors in operations at this place. A skin flap with a broad base was then detached from the roof of the skull which carried the healed-in cartilage at its frontal end. The transplanted cartilage was trimmed to a proper size and, so to speak, buttoned into the aperture, and the skin wound closed. On the second day the child had recovered from the shock, and the sutures were removed on the sixth day, when the wound looked dry and apparently normal. The child suddenly collapsed on the ninth day with manifestations of cerebral pressure.

The autopsy showed the wound had healed normally at the place of operation. There were no signs of any kind of meningitis, but, on the other hand, the ventricles were enormously dilated and the cerebral cortex was so thin as to appear like the skin covering a cyst.

It is sufficient in slight cases to cover the defect with the skin. Simplicity and rapidity in these operations, aside, of course, from the most rigorous asepsis, are the principal factors. The fact that we are operating on small children must always be borne in mind, and also that complicated plastic operations with badly nourished autogenic or even heterogenic material may easily impair the condition of the wound and increase the danger of infection, which in these cases is especially great.

In the presence or suspected presence of hydrocephalus the chances for operation are very unfavorable. In many cases it would even appear as if the hydrocephalus increased after the removal or closing of the reservoir, which in view of the thin walls often presents an enlarged surface for evaporation. The exclusion from operation of these cases, as well as those associated with extensive malformations, is all the more indicated, as these children in any case are destined to early death.

The prognosis in operations on small cephaloceles is good.

The operation for meningocele is considerably simpler and the prognosis is more favorable and does not differ from the enucleation or removal of other cysts of the cranial vault.

II. SPINA BIFIDA

Mechanism of Development and Pathological Anatomy.—Fissures and herniæ occur in other parts of the spinal canal, and these behave quite similarly to those of the cranium in regard to their pathologic anatomy as well as to their mechanism of development. These cases, however, are frequently accompanied by other deformities (club-foot, knee deformities) which point to degenerative factors.

There are fissures in the bony structure at certain places of the vertebral column and smaller or larger portions of the contents prolapse through the fissure. Sometimes they are enveloped by the external membrane; in other cases the fissure involves the skin and soft parts, leaving the spinal cord exposed.

Thus in some of the cases we have clinically a tumor covered by a thin, fine membrane like old muslin, from which fluid is constantly exuding; in other cases this is firmer, and in the lightest cases there is only a pedunculated cyst which indicates the seat of the trouble. In spina bifida occulta the skin is unchanged over the ominous spot and it is only by defects in the nerve supply that a deformity at this place can be suspected.

The fissure formation in the vertebral column and the injury to the medullary canal are common to all these cases. They differ, however, as to the degree of the injury and the processes of repair which have taken place during the period of embryonal development.

In its first biological causes their origin is obscure, while their mechanism of development is easily intelligible from a knowledge of the development of the medullary canal.

The first stage of development of the spinal cord is a flat plate, and this descendant of the ectoderm later deepens in the centre forming a groove which slowly forms a tube and becomes detached from its matrix, the external blastoderm. The chorda dorsalis is previously formed from the middle blastoderm at the ventral side, and at both sides of this formation grows the cartilaginous and later osseous vertebral column, with the body enclosing the cord and medullary canal. The canal does not close simultaneously at all places; the upper cervical and the lower lumbar sections conclude the process (places of predilection for fissure formations).

According to the degree of fissure formation we distinguish—

1. **Rachischisis or Fissure of the Spinal Column.**—If the arrest of development occurs in the natural course of development at a time when

the spinal cord is still flat and embedded without a groove in the ecto-
derm, it will remain in place, freely exposed, as a flat plate. The accu-
mulation of fluid in the arachnoidal space behind the medullary plate
will push it forward, and, so to speak, turn it inside out.

In the centre there is a velvety, highly vascular mass, often with a
central groove-like depression (area medullo-vasculosa—pure medullary
substance). A little away from the centre the covering commences with

Fig. 5.

Newborn child with rachischisis. Complete pelvic paralysis. Death on twelfth day, no operation.

its soft meningeal membranes (area epithelio-serosa); then follows the
sharply demarcated and highly vascular red-looking skin (area der-
matica).

In some rare cases the fissure also involves the anterior surface of
the vertebral bodies: rachischisis anterior (Marchand).

2. **Myelomeningocele.**—The exposed medullary plate referred to
above may become detached from the rest of the body surface by the
fluid behind it, and become attenuated to such an extent that it appears

like the wall of a cyst, but still remains discernible as medulla. The transparent sac is filled with fluid and the nerves run through its wall to the area medullo-vasculosa.

This condition may undergo a change in that the zonular formation appears blurred; epithelial layers stretch across it and often there is only a cicatricial change at the top of the sac which, together with the beginning of the nerve fibres, shows that we are dealing with the degenerated spinal cord and that the tumor signifies a prolapse of the entire cord. This is myelomeningocele.

This form also shows great defects of innervation; paralysis of the muscles which have their centre in the destroyed part is a necessary sequence. (Paralysis of the lower extremities, of the pelvic muscles, of the bladder, and of the rectum.)

FIG. 6.

Child four months old with cicatricial myelocystocele. Slight hydrocephalus present. Died eight months after operation with an enormous hydrocephalus.

3. **Myelocystocele.**—This form of spina bifida arises at a later period when the medullary canal is closed. The protrusion is forced outward by the increased pressure from within. There is an arrest of growth of the vertebral column, and the rapidly growing spinal cord not having enough room in the canal pushes through the back of the vertebral canal.

The entire wall around the sac is an extension of the central canal and is formed of medullary substance. The skin which covers the sac is at times greatly thinned by pressure, but always shows its histological layers. It is often deeply pigmented and covered with hair. There are no nerves ending in the sac itself, but they lie on its anterior aspect and pass on to the vertebral apertures—a matter of importance in the surgical treatment. This degree of deformity (Fig. 6) is not often accompanied by paralysis, but when this is present it depends on the seat of

the lesion and corresponds to the segmentary arrangement of the centres of the spinal cord.

4. **Spinal Meningocele.**—In very rare cases the soft cerebral meninges are alone prolapsed. In these cases the wall of the growth consists only of these and is nowhere adherent to the spinal marrow. The latter, with its nerve loops, frequently lies freely exposed.

5. **Spina Bifida Occulta** (Bayer, Kirmisson).—Fissures and defects are not uncommon occurrences at the lower end of the vertebral column over which the skin passes without the formation of tumors. The deep pigmentation, hair tufts, nævi, small lipomata and fibromata testify to former disturbances and healed conditions (Bayer).

The defects may be very extensive. I know of two such cases. In one there was a rudimentary development of the entire sacrum and two lower lumbar vertebræ. A partial paralysis of the lower extremities, bladder, and rectum led to the discovery, and the radiographic demonstration showed the osseous defect over which the skin passed in a perfectly normal manner. In the second case the paralysis of the bladder and rectum caused the discovery. The fissure in the sacrum lay a little lower than in the preceding case, so that the extremities were not involved.

It is interesting and characteristic for the early origin of the deformity that the peripheral paralysis from the segments of the cord corresponds exactly to the fissures in the vertebræ, while later in life the segmentary arrangement of the vertebræ and those of the spinal cord no longer correspond in normal conditions, the growth of the spinal cord being arrested and its segments lying higher than the corresponding vertebræ.

Bayer claims that tumors of the lower sacral and coccygeal regions which likewise had their origin in the displacement of the blastoderm at a very early period of development can easily be mistaken for spina bifida.

As to anatomical location, the upper and lower ends of the vertebral column are the more favorable sites, since the medullary canal closes last at these places. The seat of the disturbance can be easily located according to the known segmentary arrangement from the way the paralysis spreads.

Examination.—It is sometimes possible to obtain information as to the nature of the growth by inspection. In other cases this is difficult and sometimes it may be impossible to distinguish the various forms of spina bifida. Cases with exposed spinal cord and a pronounced medullovascular zone at once point to fissure of the spinal column or myelomeningocele. While these cases are of little surgical interest, the cystic forms that are surrounded by skin and are not complicated by paralysis command our greatest interest on account of their operative possibilities.

These tumors are of the same consistency as cerebral herniæ. They vary in tension corresponding to the pressure of the fontanelles and are partly expressible. When the sacs are flaccid the vertebral contents can be palpated; sometimes the sacs are pedunculated. By transillumination it is possible to observe dark cords, and sometimes the contents can be felt. (This points rather to a greater deformity of the spinal cord.)

Light transparent contents, great expressibility, and absence of the cord point to a cystic distention of the cavity or of the membrane of the spinal cord. (See Zappert.)

The **prognosis** varies according to the degree of the deformity. The most pronounced cases develop rapidly and terminate fatally because of infection and of the extensive paralysis of the vegetative organs. The well-covered cystic forms show few symptoms. The difficulty is that these growths have a tendency to marked distention owing to the weight of the body resting upon them. At the same time the wall becomes extremely thin, so that in any case this deformity is always a constant danger to life.

The **treatment** can rationally be only operative, and the following points will have to be determined:

1. Which cases are operable?
2. Was hydrocephalus a causative factor?
3. What operative and palliative measures are possible?
4. What methods should be selected?

The first question must be answered by humanitarian considerations. I entirely agree with Bayer that children with extensive paralysis should be allowed to die without interference. Although there is little probability of an operation being successful, yet the "misfortune" may happen that an operated child of this class will live and become a torment to itself and to everybody with whom it comes in contact. I consider it quite impossible for paralysis to be cured by operation.

In spinal meningocele an early operation (Böttcher) would offer the greatest hope were it not for the dread spectre of hydrocephalus lurking in the background. I operated on a case of spina bifida (form 3) which healed satisfactorily; but after six months the child returned with an enormous hydrocephalus from which fortunately it was soon relieved by death. Since then I have followed a different method so as to obtain better information in regard to this risk.

Under careful observation I institute gradual compression upon the tumor; this can be carried out easily by means of a metal or celluloid cap. A mould is made to fit the growth; as it diminishes the cap can be reduced in size by inserting pieces of gauze. The cap is placed over the tumor and is strapped to the body with rubber bandages. A few

days are sufficient to reduce the growth, and it is astonishing to see the transparent skin begin to assume a normal appearance. When the growth has been reduced to half its size the child is discharged with instructions to gradually reduce the size of the cap and to keep the rubber bandages applied. In order to prevent any injurious pressure upon the abdomen a kind of bridge, made of cardboard, is placed over it as a protection.

If the cranial circumference should not increase during this systematic reduction of the spinal sac the chances for appearance of hydrocephalus are unquestionably lessened. Two or three months are sufficient for observation.

This method is, of course, only indicated if there is no imminent danger to life, or in the presence of other conditions that necessitate taking the risk of immediate operation. In regard to the operation, the remarks made about cephalocele, *mutatis mutandis*, hold good here, too.

The head should be lowered to prevent, as far as possible, the exudation of cerebrospinal fluid. The sac should be ligated, opened, and the nerve cords replaced. Fistulæ from the needle wounds should be avoided and the wound closed in the simplest and strongest manner, as in cephalocele, with the child lying on its abdomen. In one instance (1906) I endeavored, in a case that was complicated with hydrocephalus, to counteract the pressure of fluid by perforating the vertebra at the base of the opened cyst and inserting a hardened artery reaching to the peritoneal cavity. As the case was one with an exposed spina bifida, and infection was already present, the chances of success were small.

It might be possible to relieve the growth and the increase of pressure from the operation by instituting drainage transperitoneally from the front before operation. As it is easier to approximate the abdominal walls to the vertebral column in a child than in an adult, this procedure can be carried out by a small incision and the subsequent operation would be considerably simplified.

The results of operation in this deformity depend upon the kind of cyst, the vitality of the child, and the simplicity of operation. In osteoplastic procedures (Gorochow) to cover a cerebral defect, the danger of even a slight necrosis should never be disregarded, since even slight suppuration may lead to serious results. For this reason the French authors, among them Kirmisson, Piéchaud, and Froehlich, prefer fascia and skin closure to all others on account of its simplicity (Henle).

All attempts to remove the entire growth by ligation or by injections are objectionable because of their danger, and in the present status of surgical knowledge these procedures should be looked upon as antiquated.

If the parents of an otherwise normally developed child cannot bring themselves to consent to an operation, which in any case involves a risk,

it is preferable to resort to the reduction of the growth by means of the protective cap above described and to trust to the elastic pressure it exerts.

Spina bijida occulta, being an aplasia of the central nervous system, is not amenable to surgical treatment at the present time, unless the existing paralysis can be symptomatically influenced by plastic and orthopædic measures on nerves and tendons. It is just in these cases, however, that the enormous power of restitution and substitution of the central nervous system is frequently exemplified.

In a case of severe pelvic paralysis I have observed progressive improvement from year to year, the uppermost segment always showing the improvement first. This slowly extended downward, so that the child after nine years has the full use of the muscles of the thighs and legs, while the small muscles of the foot, bladder, and rectum are still paretic. This auto-cure can be explained only by the creation of new centres or channels. I have never observed in any of my cases any increase of trouble from pulling the retracted spinal cord (Katzenstein).

The operations upon other growths at the lower end of the vertebral column, coccygeal and sacral tumors, are carried out according to generally accepted surgical procedure.

III. CONGENITAL HYDROCEPHALUS

(For the clinical aspect, see Zappert, vol. iv.)

Congenital hydrocephalus is nearly always present in the form of hydrocephalus internus, a cystic distention of the ventricles of the brain, which may be so extensive that the medullary substance forms but a thin cortex for the enormously enlarged cavities. The fontanelles increase in size and the cranial bones separate from each other, so that the head may assume a monstrous shape in which the rest of the body looks like a mere appendage.

The **treatment** which up to the present has been perfectly hopeless begins to promise a better outlook for the future through surgical interference. Starting from the fact that lumbar puncture causes a temporary disappearance of the pressure symptoms, attempts have been made to obtain relief by drainage of the excessive accumulation of fluid in the internal spaces. Various methods were instituted: insertion of threads and strips from subdural space into the ventricle in order to effect drainage from the interior (v. Mikulicz); also placing rubber drainage tubes from the interior of the ventricle into the peritoneum (Senn).

These attempts have been failures so far as final success was concerned, partly because of the great liability to infection of the organs involved, and partly because of the obscurity which still surrounds the real cause of the condition.

Payr's method may perhaps be attended with better results. Pieces of vein are inserted through the cerebral substance, from which the ventricular fluid is conducted to the large venous spaces. Further details may be seen from the *Centralblatt f. Chirurgie*, 1908, and the original description in the *Archiv f. klinische Chirurgie*, vol. 87, No. 4. The future alone can show whether permanent drainage of the lumbar spinal canal into the peritoneal cavity after a transperitoneal opening will be attended with better results. (See Spina bifida.)

The puncture of the corpus callosum, after the method of Anton and v. Bramann, is attractive by its simplicity, and has already been successfully applied in eight cases of cerebral overpressure. It is described as follows:

FIG. 7.

Hydrocephalus internus of enormous dimensions (circumference of head 75 cm.). Child eight months old. The dark portions of the skull represent the remnants of the cranial bones. The eyes are pressed downward.

"A small aperture is made by trephining in the skull behind the coronary suture, generally on the right side near the sagittal suture, or an oval opening is drilled with Doyen's burr. After slight cleavage of the dura a cannula is inserted near the edge formed by the union of the external and mesial surfaces of the hemispheres to the falx cerebri, and continued along the latter to the corpus callosum, which is perforated to gain admittance to the anterior horn of the ventricle.

" The fluid, which is under more or less pressure, having been evacuated, the aperture in the corpus callosum is widened by means of the cannula, so that the cavities are in intercommunication, which means that the ventricle is in communication with the entire subdural space.

"This serves to equalize the local pressure conditions, and at the same time there are new and wider spaces with more intact walls provided for the disturbed resorption of the fluid."

The other congenital affections of the central nervous system, including microcephaly, the diminutive cranium, or the premature closure of the cranial cavity have no surgical interest. The endeavors to create space for the growing brain by means of craniectomy must be considered failures. "At best," says Broca, "a complete idiot would be converted into a half idiot, which would hardly be a gain."

B. CONGENITAL FISSURES AND DEFORMITIES OF THE FACIAL SKULL

(See Moro, Diseases of the Mouth Cavity; Congenital Defects, vol. iii.)

In order to explain the fissures and defects in the area of the facial skull it is necessary to go back to that period of development in which they are still physiological. They are all remnants of primitive fissures.

Why they have failed to close and whether there was a mechanical or pathological impediment, or whether insufficient power of development was the cause, are questions which touch upon the origin of life. As a matter of fact, Hönecke, by pairing young rabbits and also rachitic animals, was able to cause

FIG. 8.
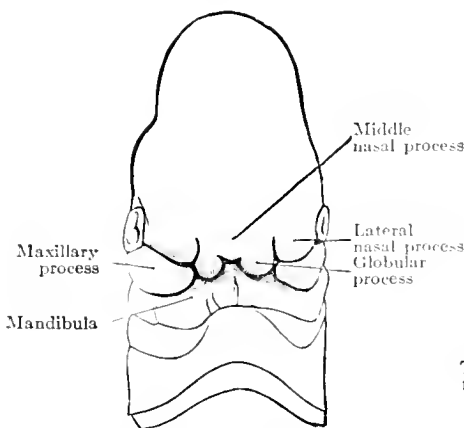
Diagram of face of embryo about four weeks old.

FIG. 9.
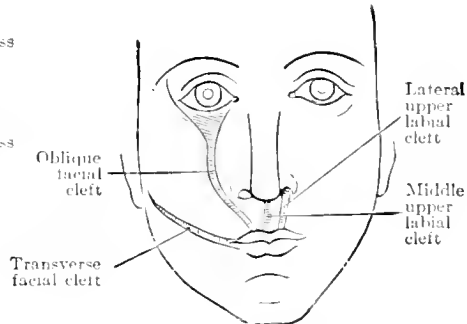
Diagram of congenital facial fissurations.

these fissures in the offspring. The same result occurred in children of chronic alcoholics. Degeneration and disturbed development deprive the organism of the power to normally complete the embryonal structure. This theory opens up a larger perspective in explanation of these phenomena than all the other theories taken together; at the same time there is no need to altogether discard the previous ones.

There is no doubt that increased intracranial pressure may lead to a fissuration in the facial skull just as well as a protruding cerebral hernia may lead to a cranial fissure. Brain tumors (Broca, Lannelonge), amniotic cords, adhesions, insufficient amnion, are usually stated as causes, but the demonstrated heredity of these deformities (Fritsche, Haug) rather favors the first mentioned etiology.

Normally, a four-weeks embryo has a dome-like cranial vault (kopf-kappe), the anterior lower margin of which (frontal process) is bordered by the primary buccal cavity. The first branchial arches grow from both sides, uniting later to form the lower jaw. Somewhat higher up two other clefts, the upper maxillary processes, grow towards the fore-head and are destined to form later the upper maxillary bone by union with the anterior margins of the head-fold. The anterior-inferior end of the head-fold likewise consists of several lobular formations which participate in the structure of the nose and the intermaxillary bone. There is no complete uniformity of opinion as to the participation of the various clefts in the formation of later organs (Kölliker, Albrecht). A system of primary furrows develops between these sprouts the persist-ence of which explains later congenital fissures.

I. HARELIP

(Lateral upper labial cleft, labium leporinum, cheiloschisis.)

Pathological Anatomy.—The fissures may be large or small, uni-lateral or bilateral, but confined to the lip (Figs. 10a and 10b, Plate 1); or they may involve the corresponding deeper soft parts, like the upper maxillary process (gnathoschisis) or the palate (palatoschisis) (Figs. 11a and 11b, Plate 1). From a slight retraction of the lip to the high degrees of fissure described there may be a number of intermediate stages. Those of the higher degrees extend into the nasal cavity, the alæ nasi losing their normal curve and stretching flat over the fissure to the extreme border of the cleft (see Fig. 12a, Plate 1).

The red color of the lips continues practically uninterrupted, but is drawn up into the fissure (Fig. 11a, Plate 1). A complete labial cleft unites with the nasal mucosa (Fig. 12a, Plate 1), and frequently there are membranous bridges and apparent scar traces as signs of incomplete transition which, according to Trendelenburg, should be regarded as late unions or raphæ and not as cicatricial formations.

Bilateral harelips may also occur as simple fissures; more frequently, however, they are deeper clefts (*bec de lièvre complex*) (Figs. 12a and 12b, Plate 1).

According to Kölliker the cleft extends between the intermaxillary bone and the upper maxillary process, or according to Albrecht between the internal and external intermaxillary bones, passing through the dental process of the upper maxillary bone and the roof of the buccal cavity in greater or smaller width.

This complication of harelip with palatal cleft, which is known as "wolf's throat," is the highest degree of deformity and nearly always associated with considerable disfigurement of the entire facial skull (Fig. 12).

PLATE 1.

FIG. 10a —Left partial harelip, intermaxillary bone somewhat protruding. Child ten months old. The lip above the cleft is very thin up into the nares. Left ala nasi flattened.

FIG. 10b.—The same child three years old, two and one-half years after Hagedorn's operation. The intermaxillary bone no longer protrudes.

FIG. 10b.

FIG. 10a

FIG. 11a.—Child two and one-half years old. Left harelip with palato-maxillary cleft; intermaxillary bone obliquely protruding. Between nares and cleft there is only a narrow scar-like bridge.

FIG. 11b —The same child ten days after Hagedorn's operation. The zig-zag scar distinctly visible. The labial end of the scar lies exactly in the philtrum.

FIG. 11a.

FIG. 11b.

FIG. 12a.—Bilateral complete palato-maxillary cleft. Child ten weeks old. Intermaxillary bone protruding in the shape of a proboscis. Alæ nasi flat.

FIG. 12b.—The same child three and one-half years old, three years after Hagedorn's operation. At the left side there is still a small notch (from the operation). The intermaxillary bone does not protrude beyond the maxillary arch.

FIG. 12b.

FIG. 12a.

The deformity most difficult to remove in after-operations is the oblique displacement of the intermaxillary bone in unilateral harelip (Fig. 11a, Plate 1) and its protrusion in bilateral harelip (Fig. 12a, Plate 1). It would seem as if nothing but the closure of the lips could guarantee the normal direction of growth of the intermaxillary bone. An excessive growth towards the open gap nearly always occurs when they do not close. When old operated cases were re-examined, it was found that pronounced oblique displacement had been equalized by the pressure of the lip by operation (Fig. 12b, Plate 1).

The behavior and direction of the teeth are of interest. Frequently they stand at right angle to the fissure and sometimes they are directed outward, a fact which should be considered in the operation (removal of oblique teeth before operation).

As regards the teeth, the fissure runs between the canine tooth and the second incisor (Kölliker) or between the first and second incisors (Albrecht). Owing to the frequent dental anomalies (3 incisors) it is often difficult to account for the history of development of the fissure.

The **prognosis** of the untreated harelip varies according to the degree of the cleft, but even the lightest degrees imply such a considerable disfigurement of the face that parents ever so averse to operations can hardly bring themselves to let the child grow up with this stigma upon him. In complete complicated fissures nutrition is impeded; besides, owing to the absence of the nasal filter these children are exposed to respiratory disorders and infection of the respiratory tract.

From times of antiquity it has always been the desire of both parents and physicians to correct this deformity as early as possible, and for this reason surgeons practised it in pre-antiseptic times. In spite of improved technic and after-treatment the operation still involves many dangers, which consist principally of hemorrhage, of traumatic infection, and not least of the gravity of the operation itself. In my experience, which comprises 132 cases, the operation is well borne by children, and the mortality is exceedingly small and a direct danger to life can be completely avoided by selection of the proper cases and the suitable time for operation.

Of 132 cases 3 died, one of gastro-intestinal catarrh twelve days after operation, one of status thymicus a few days after operation, and one of bronchopneumonia and hydrocephalus three days after operation, so that at the most only one case, that dying of bronchopneumonia, can be attributed directly to the operation.

When should a child with harelip be operated upon? This depends much less on the age of the child than on its constitution and vitality. The experience gathered at our clinic has led us to formulate the following rules:

The newborn and nurslings are operated upon in the first months of life but not until they have attained a weight of 3000 Gm. (6 lbs.). An exception is made if the deformity is so large as to imperil the child's life and the operation thus becomes urgent. Otherwise the mother is directed to suckle the child or, if this should prove impossible, to feed it with milk pumped from her breast until the required weight shall have been attained. Expectant treatment has the other advantage that children whose vitality is often questionable from concomitant anomalies, such as congenital cardiac insufficiency, etc., are removed from the operation list by death. The first point to be observed is that nurslings should be in an otherwise normal state of health. Gastric and intestinal catarrh, affections of the respiratory tract, such as coryza or bronchitis, which frequently occur with harelip, jeopardize the final result.

Treatment. — The preparation for operation does not occasion much trouble. The buccal mucosa should not be exposed to the risk of injury by too energetic scrubbing with disinfecting fluids. All our cleansing consists in washing the face with soap and water, rinsing and wiping the mouth with a light-rose colored solution of permanganate of potash.

The methods to be selected may be decided by a scrutiny of Plate 2. The French prefer the method of flap amputation of Malgaigne or Mirault, German surgeons the cross suture and zigzag suture (Wolff, Hagedorn, König). I have had the best results with Hagedorn's zigzag suture (Figs. 13 and 14, Plate 2, *k, l, m, p, q, r;* see Figs. 11b, 10b, Plate 1), principally, I believe, because it adapts itself best to variations and because the cosmetic result can be controlled much better than in any of the other methods owing to the possibility of adjusting the skin margin and adapting the cuts to existing conditions. The seemingly greater complexity admits of greater possibilities of variation, which in these very cases is of importance because there are hardly two harelips in a hundred that are quite identical and because there is hardly a cosmetic error so disturbing as a permanent distortion of the mouth. The older methods I can only endorse for very slight cases, and even in these the practised operator will prefer the zigzag suture.

The various phases are apparent from the illustrations.

Aside from the selection of the incision my experience has shown that weight should be attached to the following points:

1. Anæsthesia is in my opinion unnecessary and dangerous.

Chloroform is too powerful a poison for the child's organism, especially for a prolonged operation, which is, in any case, a shock owing to the loss of blood. Prolonged ether anæsthesia is not allowable owing to the danger of bronchitis. Young infants can be kept sufficiently still by wrapping them in a sheet and then being held between the knees by

an assistant (Fig. 13). The blood is expectorated by the act of crying, while in anæsthesia aspiration of the blood may easily occur, occluding the respiratory tract and causing pneumonia. Operating with the head hanging down considerably interferes with proper judgment of the facial contour, whose inverted appearance is unfamiliar; besides, this position increases hemorrhage.

Anæsthesia is used only when children over one year old are operated upon; in these cases the remembrance and consciousness of localization forbids this painful proceeding without anæsthesia.

2. Careful attention should be paid to the arrest of hemorrhage, little children being very susceptible to the loss of blood. The fingers of the assistant may compress the superior coronary artery. The application of small pieces of absorbent cotton, saturated with adrenalin, together with precision and rapidity on the part of the operator, will prevent excessive hemorrhage.

The use of artery forceps is not advisable, because the blood supply of the badly nourished flaps may thereby be still further impaired by pressure necrosis.

3. The first and most important part is the detachment of the soft parts from the superior maxillary bone. They should be detached and mobilized sufficiently

Fig. 13.

Operation of a left labial fissure after Hagedorn. Incision *l* of Fig. 14, Plate 2. The labial seam is ablated.

to permit making the cleft disappear without tension. If this has been properly done, any further incisions or sutures to reduce tension are superfluous. I have never been obliged to resort to them in one hundred and thirty-two cases, and would never do so because they cause a further disfigurement which is unnatural in a cosmetic operation.

4. The detachment of the vermilion border of the lip and the arrangement of the incisions should as far as possible be sharp and straight. Badly nourished and pinched tissue particles imperil the suture. For the same reason manipulations and pinching with forceps should be avoided as far as possible with the thin skin at the edge of the lips; we prefer to use the fingers.

The freshened parts should offer the broadest possible surfaces for suture.

5. The sutures should be as deep as possible, without, however, perforating the mucous membrane; they should never be drawn tight for fear of constriction and cutting through the skin. As soon as the external sutures, which in complete clefts should reach well into the nose, are tied, the mucous membrane is likewise to be sewn on the inside, because it is only by avoiding angles and pockets that accumulation and decomposition of blood and of food particles, which imperil the healing, can be averted.

6. The skin wound is painted with a resinous solution (see p. 4), over which a fine layer of gauze is placed; the nares are plugged in order to prevent the nasal secretion, which is always infectious, from exuding.

7. On the first day no milk should be given, only tea, or saccharin tea, which is always followed by a little pure water. Milk is an excellent culture ground and the mouth cannot easily be cleansed. The mucous membrane has not agglutinated and is probably unable as yet to protect itself. Milk should not be given before the second day, and then always followed by water to wash it all away. The milk is administered through a medicine dropper or a sterilized rubber nipple which must have a large opening to admit of easy suction.

8. The resinous gauze bandage remains in place until the seventh day. In the meantime the wound is occasionally painted over again, until on the seventh day the sutures are carefully removed, the wound edges having now healed so firmly that their parting need not be apprehended. Care should be taken to prevent children from sucking their fingers by applying cuffs, stiff sleeves, etc., as otherwise they would tear the wound open. The little patients are generally discharged on the eighth day.

These rules have been formulated in practice, clinically tested, and can be safely recommended. The mortality at our clinic has been reduced to 2.2 per cent., if all cases are included; omitting the cases of status thymicus and gastro-intestinal catarrh (death occurring fourteen days after operation) the figure is only 0.74 per cent.

Secondary operations should not be carried out until several months later.

For operations on bilateral harelip I use Hagedorn's method exclusively (Figs. 12a and 12b, Plate I, and Fig. 13).

The closure of the bilateral cleft is rendered difficult by the protrusion of the intermaxillary bone, which usually occurs in these cases.

It is not advisable to unite the lip over a prominent bone, because it would easily give rise to a beak-like appearance of the upper lip and,

besides, imperil the safety of the suture. In the most pronounced cases it is certainly best to remove the prominent intermaxillary bone and to use the skin flaps which correspond to the future philtrum to cover the septum, as proposed by Lorenz. Owing to the removal of the inter-maxillary bone the upper lip certainly will look unpleasantly flat and depressed, but this defect can be remedied by a dental bridge. At all events the practical result is better and the bridge teeth can be better used for mastication than those growing in the intermaxillary bone, which lacks in firmness or has been loosened by attempts at reposition: besides, these teeth rarely occupy a correct position.

The resection of the intermaxillary bone causes considerable hemor-rhage which, however, can be controlled by inserting a suture around the wound. Other authors (Bardeleben, Blandin, Partsch) suggested a cuneiform excision from the vomer or linear intersection and retroposi-tion of the vomer in such a way that the parts of the vomer will be shifted alongside each other. It has also been tried to effect in an orthopaedic way a retrodisplacement of the intermaxillary bone before closing the cleft (Thiersch, Simon). This, however, will not create normal condi-tions, because the intermaxillary and superior maxillary bones will not unite, with the result that the teeth are defective both in position and direction. In cases of considerable deformity with protruding inter-maxillary bone I consider the method of Lorenz advisable; lighter degrees correct themselves by the closed lip (Fig. 12b, Plate 1).

II. CLEFT PALATE

(Uranoschisis, palatoschisis.)

Pathological Anatomy and Symptomatology.—If the cleft contin-ues through the alveolar process and the superior maxilla (gnathoschisis, maxillary cleft) and if it further involves the upper boundary of the buccal cavity, it is termed cleft palate (palatoschisis).

The union between the hard palate and the intermaxillary bone, and further between the vomer and the velum on the side, may be par-tially or entirely incomplete. Similarly, the parts of the soft palate which develop from the two sides may be prevented from median union and thus participate in the cleft. This may be unilateral or bilateral, according to whether it occurs on one side or both sides of the vomer.

The fissure may be confined to the soft palate and the uvula, it may extend a varying distance forward through the hard palate (Fig. 15), or in rare cases it may involve the hard palate alone (uranocoloboma). Each form may exist alone or be accompanied by a cleft of the lips, as for instance in fissure of the lips and the soft palate (Fig. 16).

Cleft palate adds a considerable handicap to the living conditions of the child. The acts of sucking and swallowing are impeded, as the

milk frequently flows back through the nose. The dangers to the respiratory tract have been referred to when treating of harelip. The speech is considerably disturbed. As it is impossible to close the nose from the buccal cavity, phonation undergoes a considerable pathological change. This refers especially to the confined sounds in which air is pressed against a stenosed or occluded spot at various locations in the buccal and faucial cavities while the buccal cavity is closed from the nasal cavity by the velum drawn up and pressed against Passavant's ridge. If this closure is defective at any one place, the air current will escape toward the nose and is no longer able to accomplish closed phonation or to blow through the phonation stenosis. As a consequence, the con-

Fig. 15.

Fig. 16.

Fig. 15.—Right palatine cleft. The vomer lies closely to the edge of the left cleft. The soft palate is cleft in the middle.
Fig. 16. Left cleft of lip and jaw. The hard palate is intact, and the soft palate shows the continuation of the cleft.

sonants in question (p, t, k, s, f, and ch) cannot be pronounced, or will be pathologically and incompletely replaced in an abnormal manner (Gutzmann). Owing to the continuous vibration of the open nasal cavity the voice has a nasal sound.

The *methods of operation* are limited by the principles of incision established by v. Langenbeck. None of the other methods (Lannelongue, Lane) even approaches the simplicity, precision, and safety of the instructions of v. Langenbeck.

I have operated on forty-five cases according to this method and it has with a few modifications proved satisfactory in all. A few of the steps proposed by v. Langenbeck, such as dividing the palatine muscles, as well as chiseling off the hamulus, which was later practised by v. Billroth, have been proved physiologically deleterious to clear pronunciation.

PLATE 2.

a　　　*b*　　　*c*　　　*d*　　　*e*

f　　　*g*　　　*h*　　　*i*

k　　　*l*　　　*m*

n　　　*o*　　　*o*

p　　　*r*
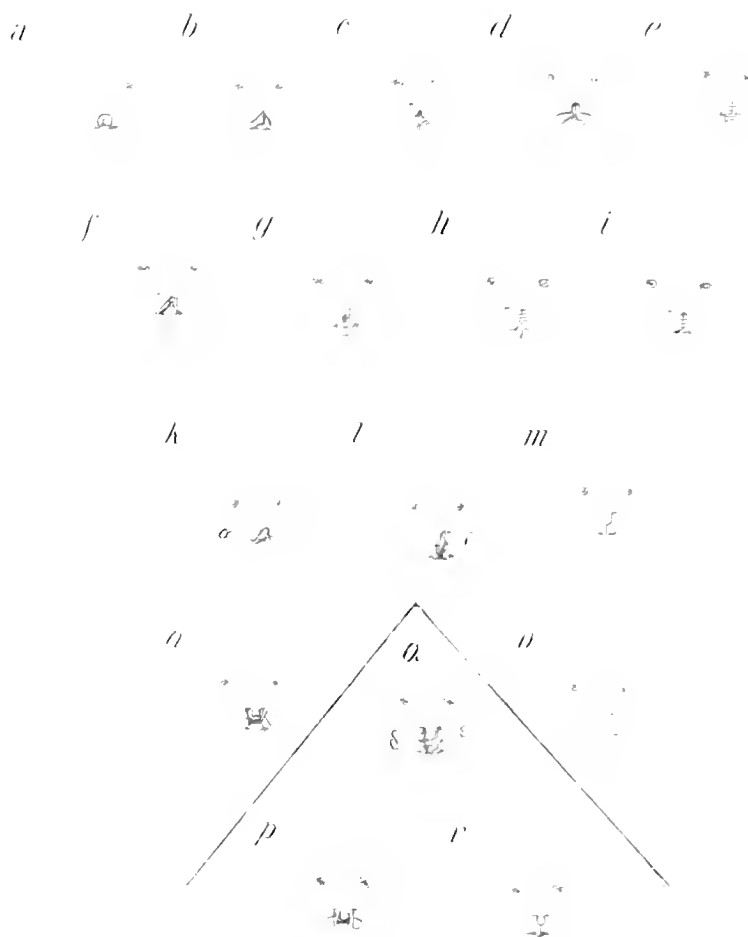
Fig. 14.—The usual method of harelip operations. *a–m, unilateral harelip.* *a*, after Graefe, arched circumscribed incision around the cleft, adjustment as in *c*, longitudinal suture; *b, c*, after Malgaigne, angular circumscribed incision (*b*), adjustment (*c*), longitudinal suture; *a* and *b* are suitable in early months or notables, as the end of the cicatrix will not fall into the philtrum; *d, e*, after Wolff, circumscribed and transverse incisions. By this method the cicatricial end of the lip may be laterally displaced into the philtrum, thus furnishing better cosmetic results; *f, g, h, i*, after Mirault, angular circumscribed incision (*f*), longitudinal adjustment (*g*), suture of the upper half (*h*), oblique excision of the inner flap, the outer one being obliquely sutured against the philtrum (*i*); Mirault's flap; *k, l, m*, after Hagedorn: *k*, angular freshening with transverse incisions; *l*, *m*, after freshening, longitudinal adjustment, the triangular flap at *y* being excised towards the dotted line; *m*, suture line, the transverse branch of which should be long enough to admit of the prominent cicatricial end falling into the philtrum.

n–r, bilateral harelip. *n, o*, after König: *n*, angular circumscribed incision with symmetric oblique lateral incisions, the centre piece being trimmed rectangularly; *o*, aspect after removal of labial seam; *p, q, r*, after Hagedorn: *p*, freshening with transverse lateral incisions, the centre piece being trimmed to a pentagon; *q*, longitudinal adjustment; flattening of the triangular prongs at *c* and *e*; *r*, suture line.

The preparation for the operation is the same as for harelip. This being attended to, Whitehead's mouth gag is inserted, with a depressor attached on its lower side, this mechanism allowing any desired depression of the tongue (Helbing).

Here again I employ the drop method of ether anæsthesia. The child is lightly anæsthetized, the analgesic stage being used for operation, while the intermittent stages of awakening are utilized for compression, arresting hemorrhage and renewing anæsthesia. This procedure is incomparably gentler than the deep chloroform anæsthesia generally adopted, since this adds another shock to that of operation.

The illustrations will explain the method of incision: An incision is made to relieve tension along the dental border not too near the cleft so that the bridge need not be too narrow. Posteriorly the incision may turn around the last tooth and terminate against the cheek so as to obtain the broadest possible flap. Then follows detachment of the periosteum from the hard palate and amputation of the fold of the nasal mucous membrane. The resulting cavity is filled with adrenalin cotton plugs, and the other side is treated correspondingly. Now the edges of the fissure are freshened as closely to the margin as possible, always taking care that broad surfaces will result for the union. The knife should be held obliquely.

If the detachment has been successful and the cleft is not excessive it will be seen that the flaps have now become approximated. I have only in very rare cases been obliged to encroach upon the hamulus for purposes of mobilization.

Now follows the suture, for which I always use silk thread and ordinary highly curved needles. Many operators prefer wire sutures.

First suture the uvula, tie the sutures immediately, pull them forward and unite the velum at the back as high as possible. Then the sutures follow in proper sequence from back to front. The most important points are that the incisions be sharp, the sutures deep, and that the wound edges lie broadly against each other. The sutures should not engage the flaps broadly, nor should they be tied too firmly, in order to prevent defective nutrition of the flaps.

Having closed the wound, I run two or three narrow bands from the lateral fissures around both flaps. They are tied rather firmly and the knot turned so that it can be placed in the nasal cavity. This procedure has been applied in our clinic with great success ever since 1902 to reinforce the sutures. Tamponading the lateral fissures is rendered superfluous by this method and in most cases it prevents congestion of secretions (fever, glandular swelling) (Fig. 17).

For the first two days after operation the child is given a little tea and water and is kept as quiet as possible, taking care that there is no

talking or crying. Milk, being a good culture medium, is not allowed before the third day, and then only diluted and followed with pure water.

Any other kind of mechanical cleansing is impractical in little children, while older ones should rinse the mouth with a 2 per cent. solution of peroxide of hydrogen. If necessary, the reinforcing bands are renewed on the seventh day with the aid of a large blunt ligature needle and the silk stitches removed. Any small fistulæ will close well by drawing the holding bands tighter, and these are not removed until healing is effected. If the cleft is too large it will be necessary to close any remaining defects by flaps amputated from the lip, vomer, or cheek (v. Eiselsberg, Rotter, and Lane).

Fig. 17.

Picture of an operated palatal cleft after suture, a and b being the narrow reinforcing bands

If the operation has been successful the palate will have a natural appearance. Deglutition will be facilitated, but speech generally remains defective. The velum being small and short, Passavant's ridge can be reached only with difficulty even if the velum muscles have remained intact. Gutzmann's linguistic exercises can now be commenced. Gutzmann has devised an elevator by which the velum can be raised, stretched, and massaged by the patient himself.

The linguistic exercises are especially directed toward the normal pronunciation of the palatal sounds, and in many cases are attended with excellent results. In cases where the lower margin of the velum is separated too widely from the posterior faucial wall, a lateral incision of the palatal arches in order to mobilize the wall, or a paraffin injection to enlarge Passavant's ridge, will help to correct this condition.

From this description it follows, as a matter of course, that it is in the interests of the patient to create normal conditions before the physiological development of speech commences, the need for normal use of the organs of speech being greatest at that period.

For this reason I am unconditionally in favor of early operation, which means as early as the general condition of the child shall permit; not before the end of the first and not, if possible, after the third year. Well-nourished children, from eighteen months to two years old and weighing from 24–30 pounds, bear the operation well. I have never been obliged to divide the operation into two parts (Wolff, Helbing), and in any case this means a twofold tormenting to the child, a twofold anxiety to the parents, and twofold danger from the anæsthesia. But

I admit that with weak children this procedure may be considered in a given case.

In very wide clefts, or in cases where owing to a previous operative failure there is but little plastic material left, I have great hopes for the preliminary approximation of the upper maxillary halves from applying a suitable dento-orthopædic apparatus (endless screw). Helbing states that the parts may sometimes be approximated by more than 1 cm.

Large fistulæ render necessary a second operation similar to the original one. Small fistulæ will close with the aid of holding bands or by application of caustics.

If the entire suture reopens, a new attempt at closure should be made not less than six months after the first operation.

Treatment by prosthesis and obturators (which has recently been again recommended by Suersen, Schiltzky and Warnecross) cannot replace operation. Obturators are expensive and must be frequently renewed during the period of growth and are generally disliked by patients. Children can only with difficulty resist the temptation of carrying the obturator in the pocket rather than in the mouth.

III. RARE CLEFTS, FISTULÆ AND CONGENITAL TUMORS OF THE FACE

Aside from the more frequent congenital facial deformities referred to, such as harelip and palatal cleft, other more or less rare defects may occur in the facial skull owing to non-union of primordial lobes. By the non-union of the upper maxillary process with the lateral nasal process a rare fissure occurs which is designated as—

Oblique Facial Cleft.—According to Morian it commences as a lateral harelip, extends into the nares and further up toward the eye, produces a cleft in the lower eyelid (coloboma) and often continues obliquely beyond the upper lid toward the forehead. There is another form which likewise begins as harelip, but runs laterally alongside the nose to the eye. A third rare form begins at the angle of the mouth and extends to the region of the infraorbital canal (Fig. 18).

The lightest forms, consisting of harelip and coloboma at the inner canthus, should be treated on the surgical principles we have discussed. More extensive defects demand more complicated plastic procedures, which will vary with the requirements of each case. The relief of defects of the mucous membranes presents great difficulties in these cases.

Transverse facial cleft is a gap between the upper maxillary process and the lower maxillary arch. The mouth is enlarged toward the ear, and frequently a raphe extending to the ear indicates the retarded incomplete union (Chavanne, Ashby and Wright, Forgue). (See Fig. 18.)

The development of the lower lip presents the very rare occurrence of median fissures. The same kind of fissures may occur at the upper lip and the nose, which, according to Lannelongue, may be explained by a notch of the median frontal process or, better perhaps, by its total absence. Landow, Broca, Kredel, and others observed a lateral nasal fissure which appears as a defect of the ala nasi or runs right through one of the nasal cavities; in the latter case it resembles an oblique facial cleft.

Fig. 18.

Child six weeks old Right side: oblique facial fissure running into the eye and extending beyond it. The cleft also involves the upper maxillary bone. Left side: transverse facial cleft. Scar-like tissue extending to the ear.

This ramification of deformities allows considerable opportunity for the formation of fistulæ (incomplete closure) as well as for excess formations of all kinds, among which deep displacements of ectoderm nuclei may be described.

Facial fistulæ may, for instance, be found at places where there are fissures of the upper and lower lips.

More frequently fistulæ occur in the region of the external ear. They are often bilateral and symmetrical, and owe their origin to the non-union of the various parts of the palatal arch which participate in the structure of the ear.

The fistular ducts may assume a cystic character by partial or total occlusion of the lumen and by accumulation of the secretions of the mucous glands of the cystic wall.

It is at these very places that *fibrochondromata* very frequently occur (Fig. 19), which may be observed as small, pendulous, skin-covered appendices at the sides of the helix or in the neighborhood of the palpebral fissure. They are generally covered with skin and contain adipose tissue and a cartilaginous nucleus (descendants of the middle blastoderm).

Teratoma and dermoid cysts in the region of the face and skull are excess formations from scattered nuclei of the ectoderm which have undergone independent development (Kaufmann). They are mostly found in the vicinity of the osseous sutures and primordial fissures. Pathologico-anatomically they are characterized as small, slowly growing subcutaneous tumors, above which the skin is normally movable. They consist of a coarse sac containing, aside from tallow and epithelia (detritus), all those structures which the ectoderm is capable of producing (hair, teeth).

Histologically this sac is of the same structure as the outer skin (see Tumors, Sebaceous cysts). In the region of the head they are most frequently found at the glabella, in the vicinity of the sutures, at the orbital margin, near the ears, and in the buccal cavity.

Fig. 19.

Child four weeks old (monophthalmos). At the outer canthus of the right lid is a pedunculated fibrochondroma. At the inner margin of the lid the primitive ectodermal gemmule with typical goblet form and central indentation.

The only possible **treatment** of all these formations, fistulæ, cysts and tumors, is their operative removal, which can easily be accomplished on ordinary surgical principles.

In the interests of a cosmetic result the incision should be small and well concealed by observation of the direction of the skin lines, using natural folds and hairy parts.

Aside from the defects and deformities in the buccal cavity which have already been mentioned, another important anomaly may occur, consisting of the complete occlusion or exaggerated diminution of the mouth fissure which, according to Amonn, Ahlfeld, is attributable to defective development of the entire first branchial arch. In rare cases

there is total absence of the tongue (Spiller, Griffith), while a median fissure of the tongue, or lingua bifida, is of more frequent occurrence.

Adherent tongue (ankyloglossum, tongue-tie) is a frequent anomaly that confronts the pediatrist. Owing to a shortened frenum the tongue is broadly adherent to the floor of the buccal cavity. The adhesion is often quite superficial and can be easily severed with a spatula, or the tongue can be promptly liberated by sharply nipping the frenum with the scissors. There would seem to be no need for a deeper incision that may injure larger vessels. The operation is really only indicated in cases where the tongue can positively not be protruded beyond the alveolar margin. Sucking or speaking is in no way impaired by a short frenum, as is often believed.

Macroglossia, or giant tongue, has seldom been observed as an independent pathological process (see Moro, vol. ii).

It is generally a symptom of other pathological conditions, such as idiocy, myxœdema, mongolism, acromegaly, and in these cases the entire interstitial tissue is augmented.

In other cases, however, a large swollen giant tongue of blue-red appearance, protruding through the open mouth, signifies a more or less extensive lymphangioma or hæmangioma of the tongue (see Tumors), according to whether the cavities with which the tongue is interspersed belong to the lymphatic system or to that of the blood-vessels. In many cases the tongue is abnormally large at birth, or at all events the anomaly is not at once noticed. The buccal cavity becomes only gradually filled by slow but steady growth of the tongue, which is finally forced out of the mouth, the impression of the teeth being distinctly visible on it. The growth of the teeth as well as of the jaws is interfered with by the constant pressure of the increasing enlargement.

The tongue is not always involved in its entire extent, but in all cases the mucous membrane is firmly and inseparably connected with the enlarged parts (differential diagnosis from other growths).

On account of the tendency of this congenital enlargement, even if only of slight extent, to bleed, there is always the possibility of infection as a source of danger to the child.

The **treatment** consists in the destruction of the enlargement by the thermocautery or excision of the parts involved.

If the enlargement is general, repeated partial excisions will be necessary and should be preceded by bilateral ligation of the lingual arteries owing to the degree of severe hemorrhage (von Bergmann, Fehleisen).

Similar congenital growths occur at the chin, lips, and eyelids.

C. CONGENITAL ANOMALIES IN THE DEVELOPMENT OF THE NECK

I. CONGENITAL FISTULÆ OF THE NECK

Pathological Anatomy.—In the same manner that facial clefts and fistulæ may result from branchial clefts and sulci, so the embryonal development of the neck may give rise to incomplete closures, to scattering of nuclear particles, and to persistence of primordial sulci and ducts.

At the sides or in the median line of the neck small fistulæ may be observed which secrete a milky fluid either spontaneously or upon pressure. According to their location these fistulæ are divided into median and lateral. The lateral ones are always situated at the anterior margin of the sternocleidomastoid muscle above or below the hyoid bone (Karewski). These have an internal communication in the vicinity of the tonsil while the median ones open under the tongue at the foramen cæcum.

These fistulæ may extend from the skin through the cervical tissues into the buccal cavity, and then they are called complete fistulæ.

According to whether the fistula terminates in a cul-de-sac or has only an interior or exterior aperture, they are called incomplete exterior or incomplete interior fistulæ.

The intrusion of amniotic bands into the embryonal furrows, etc., is said to explain these malformations as in the deformities of other parts. Heredity, which has frequently been observed in these cases, brings up the biological factor for consideration.

Up to a short time ago there was not much uniformity of opinion as to the history of development of these structures. Ashersohn was the first to assume a connection with the branchial clefts. According to Rabb they are remnants of the branchial duct which runs outward from the second inner branchial furrow to the sinus cervicalis, which latter corresponds to the second exterior branchial furrow in which the third and fourth branchial ridges will be situated later through processes of growth and involution (Karewski).

All these explanations, however, do not answer the question as to the etiology of the median cervical fistula. At first it was assumed that it was a communication with the glottis, but this has never been proved. Investigations by His, however, have demonstrated that the median cervical fistula can be explained without difficulty by the development of the median lobe of the thyroid gland.

In a two-weeks-old embryo the anterior wall of the primitive buccal cavity develops a recess lined with cylindrical epithelium and growing downward in the form of a duct. Cells begin to form at the wall which later show the character of thyroid gland. The lower end of the duct

develops into the thyroid, while the upper end is obliterated. But in about 30 per cent. of adults particles of thyroid consistency, mucous glands which were swept along, epithelial debris and lymph follicles, are, according to Weglowsky, found scattered along the entire route from the foramen cæcum to the thyroid cartilage.

Occasionally the entire duct, or its anterior or posterior end, may persist in the shape of a fistula, and parts of the duct may later appear as cysts. Development on this principle also explains the histological difference in structure and lining of these fistulæ and cysts.

According to further investigations of Weglowsky the lateral cervical fistulæ originate in a similar manner. In the third week of embryonal life two cavities are formed at the sides of the pharynx in the fourth and third fissures which are changed into canals by growing downward. The canal originating in the fourth fissure is changed at its lower end to thyroid tissue, while that of the third fissure is intended for thymus formation. It runs transversely over the entire neck and ends at the sternum. The canals are lined with cylindrical epithelium, but in places stratified pavement epithelium may be found. Mucous glands and lymphatic structures are embedded in their tissue. According to this explanation the lateral fistulæ will have to be regarded as remnants of these canals. Their course coincides with that of the thymus duct which commences below the tonsils, passes downward and outward over the hypoglossus nerve, and gradually disappears in its course toward the sternum between the carotids to the inner border of the sternocleidomastoid muscle.

The thyroid ducts are shorter and terminate in the vicinity of the glottis.

This explanation brings uniformity into the etiology of all cervical fistulæ and the cystic structures resulting from them, whether they have developed from canal remnants or follicles or as dermoid cysts from epithelial masses that have been swept along.

The fistulæ, when freely exuding, are not only uncomfortable to the patient, but also frequently lead to eczema of the skin at the site of the discharge.

The **treatment** of fistulæ as well as their corresponding cysts can only consist in radical extirpation, care being taken that their removal be as complete as possible (resection of the hyoid bone), since any vestiges may lead to relapses and cyst formation. The extirpation will be considerably facilitated by the previous passage of a hair sound, but the wall of the ducts is usually so tender that a false passage may easily be made (Broca, v. Hacker).

Any other method of treatment, **cauterization**, etc., has practically no beneficial effect.

II. LYMPHANGIOMA (HYGROMA), COLLI CYSTICUM CONGENITUM

Pathological Anatomy.—Among the congenital tumors of the neck lymphangioma cysticum occupies a position of its own (Figs. 20a and 20b).

It is a multilocular tumor, laterally situated in the vicinity of the large vessels which it encircles, has a downward course toward the clavicle, penetrates underneath it into the sternal muscles, and may finally grow around all the vessels of the neck, larynx, and œsophagus, and lead to death by suffocation. Section through the growth shows a meshwork of connective tissue, the cavities being lined with endothelium and filled with clear lymph. (As to **etiology**, etc., see Tumors.)

Fig. 20a.

Fig. 20b.

Fig. 20a.—Hygroma, Colli cysticum congenitum. Child two years old, with large multilocular cystic tumor. The skin over the growth is movable. The various cysts reach into the supraclavicular fossa.
Fig. 20b.—Same child as in Fig. 20a. Some of the cysts perforate the floor of the mouth and appear under the tongue in the shape of vesicles, raising the tongue upward.

The size of the cysts varies; they lie close together, resembling a bunch of grapes and are usually firmly adherent to the surrounding parts, skin, periosteum, and muscles. Their adhesion to the blood-vessels is particularly intimate, so that occasionally there is a transition into a vascular tumor (Bayer).

The **prognosis** is decidedly unfavorable owing to the rapid growth of these tumors. Their peculiarity of penetrating into all loose tissues and to surround all organs, which they slowly stifle, renders expectant treatment particularly dangerous.

The **treatment** can only consist in radical operation. The peculiarity of the tumor to firmly adhere to its environment and its often widely

extending ramifications into the intercellular cavities, considerably complicates their extirpation, which even becomes impossible in cases where the tumor has already encircled the median cervical organs and involved the opposite side of the neck (Fig. 20b).

Difficulty in deglutition and respiration, as well as digital examination both inside and outside the pharynx, will furnish information on the extent of the growth.

Relapses may easily occur emanating from inaccessible or overlooked tissue gaps, even after complete extirpation of the tumor. As a rule, the operation is followed by prolonged lymphorrhœa which, however, is self-limited and only becomes dangerous from the great infectiousness of the wound, which is continually wet.

Aspirations and injections are of little value owing to the multilocular consistency of the growth, while its rapid and dangerous development will not admit of losing any time by punctures, cautery, or electrolysis.

III. CONGENITAL TORTICOLLIS

Torticollis does not occupy a uniform position among the deformities. The larger portion are undoubtedly congenital, but there are a number of cases in which it is only a secondary or part manifestation of other affections.

Nevertheless it may be discussed here from a uniform point of view, considering that the pathological anatomy, symptomatology, and treatment are the same in all cases.

Etiology.—Heredity, which I have observed in a case of mother and son, and the frequent simultaneous occurrence of other anomalies, such as dislocation of the hip, deformities of the shoulder-blade, or harelip, point to the probability of incomplete or abnormal development in many cases. At the same time, numerous observations favor the assumption of a considerable influence being exercised by mechanical intra-uterine and inflammatory processes and adhesions (Petersen, Völker).

On the other hand, the traumatic explanation of a tear in the sterno-cleidomastoid muscle during delivery is supported by many observations. Animal experiments throw no light upon the matter, since the head of animals develops under different static conditions. Von Mikulicz and Kader attribute the development of torticollis to the interstitial chronic myositis which has followed the trauma and which leads to cicatricial change in the muscle.

Again, other cases are positively known where no torticollis developed from a distinctly palpable hæmatoma caused by forceps delivery (personal observation).

The transfer of micro-organisms by the blood has been held responsible for the infection, but this has never been demonstrated. Torticollis has also been noticed to develop at later age following the injury of a muscle (Bouvier, v. Eiselsberg, v. Billroth).

It would appear, therefore, that the coincidence of various factors is necessary to occasion the cicatricial degeneration of the muscle. The location of the lesion, pressure on the nutrient artery, and injury to the nerves are in all probability factors in the case.

Torticollis occurring after birth may likewise be of widely different origin.

As a matter of course, in later life other injuries to the bony and muscular parts of the neck may cause the characteristic attitude of the head. High-seated deformity of the vertebral column, unilateral tuberculous foci of the cervical vertebræ, infectious or suppurating processes in the vicinity of the vertebral column or of the sternocleidomastoid muscle, otitis with glandular swelling, may from the position of the head due to the pain cause a subsequent cicatricial fixation and lead to torticollis. Thus, occipital periostitis, suppuration of glands by the side of or underneath the sternocleidomastoid may cause this deformity. I have observed a case of "pediculus eczema" in which the torticollis that had existed for six months immediately disappeared with the removal of the "exciting factor." Rheumatic processes as well as spastic affections of the sternocleidomastoid on a neurogenic basis may likewise lead to the same clinical symptoms.

The **symptoms** can be explained anatomically by the unilateral shortening of the sternocleidomastoid and by analysis of its function. Any further changes have resulted secondarily by adaptation to the changed conditions of growth.

The head is rotated toward the sound side and deflected toward the affected one. In this position it is fixed in so far as an increase of deflection and torsion is possible, but a decrease of the same is not likely (Figs. 21a, 21b, 21c).

These two cardinal symptoms may differ in intensity according to which portion of the muscle is shorter, the sternal (torsion) or the clavicular (flexion).

The head appears deflected toward the sound side owing to the contiguous lateral scoliosis of the cervical vertebræ, while the unilateral traction produces a facial asymmetry. According to the investigations of Witzel, Milo, and Böhm, all the cranial bones participate in the scoliosis, the cause of which is supposed to be the unilateral traction as well as the disturbance of the muscular balance. No doubt we have here to deal with an adaptation of growth conditions to change static foundations. In facial scoliosis the eyes and ears are not in a horizontal line

and the position of nose and mouth is oblique. The resulting lateral curvature of the vertebral column leads to further compensatory scoliosis of the vertebral column, conformably to the natural requirements of its structure and function (Fig. 21b).

The diagnosis cannot present any difficulties after these explanations. Muscular torticollis need be considered only if the degenerated shortened muscle is distinctly palpable as a hard, wire-like, protruding edge. If the muscle is merely contracted, it will be necessary to

Fig. 21a.   Fig. 21b.

Fig. 21a.—Torticollis congenitus dexter. Girl seven years old. Easy delivery, cranial presentation; facial asymmetry less distinct, torsion of the chin to the left, flexion of the head to the right
Fig. 21b.—Same child as in Fig. 21a. Considerable left scohosis of the neck, which also involves the thoracic vertebræ.

search for the cause of such voluntary or reflex contraction. The cause will usually be found in the presence of some painful process which causes the muscles of the neck to assume a permanent position in which the pain is least felt.

Examination of the vertebral column from the back of the neck and from the pharynx, and Röntgen photographs from the side and through the open mouth, will give information about the conditions prevailing in the upper part of the spine.

In one of my cases there was marked deflection and torsion of the head with normal sternocleidomastoid in a boy of eight years. A lateral X-ray photograph, together with the history, showed that the cause was

occipital periostitis which had involved the neighboring vertebral articulations, and had resulted in a subluxation between the first and second cervical vertebræ. The position adopted was due to the pain and the head became permanently fixed. Treatment by heat and a light extension effected a cure in a few weeks, although the condition had persisted for months.

Tuberculous processes located laterally in the bodies or arches of the vertebræ are demonstrable by the X-ray picture. A diagnostic skin

Fig. 21c.

Congenital torticollis. Girl eight and one-half years old. Normal delivery; considerable cranial asymmetry; cord-like protrusion of the left sternocleidomastoid; the head deflected toward the right; scapular lines of uneven length.

test (v. Pirquet, Moro) will aid the differential diagnosis. The treatment is then identical with that of spondylitis (which see).

The **treatment** of true congenital muscular torticollis can only be operative, and consists of open section or partial extirpation of the cicatricially changed muscle.

Subcutaneous section of the shortened muscle with a short, curved knife was practised a long time ago by physicians (see Joachimsthal).

In pre-antiseptic times Strohmeier and Dieffenbach were among the most enthusiastic adherents of this method.

When it became possible to treat open wounds without danger, subcutaneous section was abandoned, on account of its danger from close proximity to large vessels. The external jugular vein and the irregular transverse veins are near the field of operation, and, moreover, it is impossible, groping in the dark, to sever all the shortened cords of the muscle and enveloping fascia.

Open section is generally made at the lower portion of the muscle where it divides into two heads. In carrying out the operation the greatest importance should be given to the cosmetic result, and long, ugly incisions which are not well covered should be avoided.

A transverse incision a few centimetres long and lying exactly in the cervical fold is sufficient. Longitudinal incisions heal in irregular approximation to the fascia and cause a very objectionable scar.

The skin, platysma, and muscular fascia being incised, the muscle is at once exposed. The operation can be greatly facilitated by having an assistant push the muscle outward with two fingers. This also prevents hemorrhage. The muscle is isolated in the wound itself and both heads incised over a grooved director, layer by layer, care being taken that all scattered strands are really cut through. By manipulating the edges of the wound the cavity can be easily searched. The connective-tissue strands which lie in the muscular fascia must likewise be cut through.

If the cicatricial degeneration of the muscle is very extensive a partial excision (v. Mikulicz) may be done. By bending the head toward the affected side the cicatricial part of the muscle can be pulled out of the wound to a considerable extent and cut off, care being taken not to injure the spinal accessory nerve. In this way the objectionable longitudinal incision, which had been proposed by v. Mikulicz, and the resulting scar are best avoided.

In cases with slight shortening of the muscle it is also possible from the same incision to carry out Föderl's plastic operation, which consists in severing the clavicular portion at the clavicle itself, cutting through the sternal head at the bifurcation, and then uniting both heads. In this way the length of the muscle is increased by the length of the clavicular portion. The skin of the neck being easily movable permits a satisfactory adaptation of the wound edges after a little practice.

After the operation the wound is closed without drainage. For this purpose Michel's clamps are best, as they approximate the skin broadly and leave no puncture canals. Otherwise a subcuticular suture should be made.

Lorenz recommends the application of an overcorrecting apparatus after operation to force the head over to the opposite side. Considering that the neck is an exceedingly important organ, this manipulation would require the greatest care.

I prefer the excellent absorbent cotton correction bandage of Schanz. The neck is enveloped in an extremely thick layer of absorbent cotton, which is fixed by bandages; then follow more cotton layers and bandages until the head, owing to the power of expansion of the cotton wool, will not only become fixed, but even assume a position of extension. By applying cushions of uneven thickness any desired oblique position or overcorrection can be attained and retained. The bandage may remain undisturbed for several weeks.

The **after-treatment** consists in the treatment of the scoliosis of the cervical vertebræ which may already have developed in older cases. In this treatment all the apparatus and methods formerly used for the bloodless treatment may be applied.

Among other methods of operation Lange's section of the upper end of the muscle may be mentioned. In this operation the cicatrix, being at the hair border, can be easily concealed.

Wullstein's method of plastic shortening of the muscle of the opposite side will hardly become necessary in children.

The bloodless methods are limited to equalization or overcorrection of the pathological position either by forcing the head to hang down obliquely in Glisson's sling, or to manual overcorrection, or to wearing a portable apparatus for fixing the head in a position of overcorrection. This can be achieved by plaster of Paris, celluloid or hard leather collars, etc., or by traction devices which comprise a band attached to the head and shoulder, to the pelvis, or to a special corset (Sayre, Lorenz, Hessing, Hoffa, and others).

Recamier originated and Lorenz revived the subcutaneous tearing of the muscle to avoid the external scar. Codivilla added a pinching forceps to facilitate the severing of the muscle.

I prefer the open section as being less dangerous, observing the necessary care as to cosmetic results, since the operation is easy and asepsis attainable in so small a wound.

The success of the operation depends upon the secondary results which the deformity had already occasioned. The consecutive curving of the vertebral column is an unpleasant complication which favors relapses, and we know also that torticollis results from the faulty position in pronounced scoliosis. Thus we can easily enter upon a vicious circle.

Facial asymmetry and the resulting habitual attitude of the head and the axis of the eye render correction difficult, especially if com-

plicated by stunted growth of the other muscles on the affected side. All these factors demand early operation in congenital torticollis. As early as the first few weeks a bloodless corrective treatment should be instituted by the insertion of cushions on the affected side. If the hæmatoma is still palpable it should be treated by massage, heat, and resorbents (iodine). Portable apparatus (collars) are not applicable in the newborn owing to the tenderness of their skin. By the treatment outlined above I have been able in various instances to prevent the development of torticollis in spite of an originally present hæmatoma. If the symptoms, however, should become more pronounced in the first few months in spite of the corrective treatment, I advise immediate operation.

The operation is slight and almost bloodless, and can be carried out in infants without anæsthesia, and as children at that age are always in the recumbent position the after-treatment will meet with no difficulty whatever. (Overcorrecting plaster-bed; see "Spondylitis" for instructions how to make it.) Fixed scoliosis is not yet present, while the facial asymmetry which certainly occurs even in the first few months corrects itself after removal of the causative affection by reason of the intensity of growth during that period. (I have obtained the best possible results in twenty operative cases of this kind.)

The treatment of the other forms of torticollis has already been described. If torticollis is merely an accompanying symptom of some other affection, the treatment of the two conditions will be combined, always taking into due consideration the topographico-anatomical conditions of the neck.

Rheumatic torticollis is very rare in children and I have only observed it a few times in later childhood where an arthritic tendency existed. As a rule it yields in a short time to energetic massage and antirheumatic treatment.

Neurogenic, spastic or clonic torticollis is likewise a rare affection in children. I have seen it only once in a girl thirteen years of age with a neuropathic tendency. A plaster collar for fixing and considerably overcorrecting the deformity made it disappear in four weeks. Otherwise section of the nerve supplying the muscle (spinal accessory) has been recommended (Kocher), and in very pronounced cases the section of the posterior branches of the first four cervical nerves (Kennedy).

D. CONGENITAL DEFORMITIES OF THE LOWER PART OF THE BODY

Development.—The congenital malformations of the digestive tract and of the genito-urinary organs are so closely related to the history of development of the lower parts of the embryonal body that it is impossible to separate them. They are so frequently complicated with

each other, as for instance in the development of the rectum and the genito-urinary organs, that the assumption of common stages of embryonal development is justified from the malformations alone.

For the better understanding of the matter a short survey of the fetal development of these groups of organs may be given, to which reference will be made as we proceed. The details have been taken from the publications of Strahl, Kaufmann, Keibel, and Stieda.

Even the very earliest embryonal stages in the human being show completely developed investing membranes (H. Strahl). Before the appearance of the primitive vertebræ the amnion, originating from a protrusion within the ectoderm, represents a closed cystoid fold of the embryonal integument. The vitelline membrane is still upon the open ventral side, and the lower end of the body is connected with the inner surface of the chorion by a short cord called the ventral pedicle (His's Bauchstiel). An ectodermal diverticulum, corresponding to the allantoid duct, which later develops into the cavity of the bladder, protrudes into the pedicle.

This ventral pedicle develops later into the umbilical cord and contains the umbilical veins and arteries and the extracorporeal parts of the vitelline membrane and of the allantois. The amnion grows rapidly and reaches the chorion, to which it intimately clings. The umbilical cord grows longer, and the extracorporeal part of the vitelline membrane becomes obliterated. The portion of the small intestine which was originally situated in the umbilical cord and communicates with it through the ductus omphalomesentericus, has already been drawn into the abdominal cavity and the placenta still contains insignificant remnants of the vitelline membrane. (See Meckel's diverticulum, Umbilical hernia.)

The bladder is formed from the intraperitoneal portion of the allantois, which disappears in the duct contained in the ventral pedicle or umbilical cord, as well as the portion which runs from the future fundus of the bladder to the umbilicus, the urachus or ligamentum vesico-umbilicale medium. (See Urachus, Urachus fistula.)

The formation of the bladder takes place by means of a division of the cloaca, which orginally represents at the posterior part of the body the connection between the genito-urinary canals on the one hand and the large intestine on the other (Kaufmann, Keibel). Into this cavity the peritoneum is inverted from the top, dividing it into a dorsal space —the rectum, and a ventral space—the bladder. Both spaces remain in connection for a long time. (See Anal anomalies, Fistulæ.)

Finally the septum arrives at the exterior membrane of the cloaca, whence a frontal septum grows to meet it, and this union effects the separation between rectum and the genito-urinary system. Between

both systems the perineum is now established. Between the umbilicus and the anterior membrane of the cloaca the abdominal wall advances forward, separating them from each other. Arrest of this development gives rise to abdominal and vesical fissures or epispadias.

The dorsal section of the cloacal membrane, or anal membrane, still closes the rectum exteriorly and the anal groove is meeting it from outside. The definite perineum continuing to develop, the anal membrane is forced more and more downward, until it finally disappears. This establishes the exterior communication of the rectum. (See Atresia ani.)

Previous to the separation of bladder and rectum the genital protuberance arises from without and in front of the cloacal membrane, the protuberance being surrounded by the genital folds formed by the sides of the cloacal membrane. Around this rudimentary structure arise the genital ridges. Toward the end of the second month the genital protuberance shows a ventral groove which in the male forms the long urethra with the aid of the genital folds, a small gap remaining at the glans penis. It is only later that the genital ridges grow together to a raphe, forming the scrotum. (See Hypospadias and Hermaphroditism.)

In the female the genital protuberance develops to form the clitoris, the genital folds forming the labia minora which encircle the clitoris and the sinus urogenitalis or vestibulum. The genital ridges persist as labia majora. From within, at both sides of the vertebral column, the mesonephros (primitive kidney or Wolffian body) is formed about the fourth week, the excretory ducts of which (the Wolffian ducts) discharge into the sinus urogenitalis.

A strip of epithelium develops from the lateral surface of the mesonephros, which later becomes Müller's duct, and a second cell-nest at the mesial side which is called the germinal epithelium. From the latter, together with the mesonephros, the testicles are developed, the mesonephros supplying the canals to the nuclear epithelium, while the duct of the mesonephros forms the vas deferens. Müller's ducts become involuted, leaving but a few rudimentary parts (hydatids, utriculus masculinus), while the testicles, together with their peritoneal folds, are drawn from their place of origin into the scrotum through progressive growth. (See Hernia.)

In the female the ovaries develop instead of testicles from the nuclear epithelium and mesonephros, settling at both sides of the uterus along the inguinal ligament. (See Ovarian hernia.)

Nothing but rudiments, Gaertner's ducts, remain of the canals of the mesonephros, while Müller's ducts develop into the tubes which unite with the uterus and vagina. (See Uterus bicornis.)

I. MALFORMATIONS OF THE UMBILICUS AND FISSURES OF THE ABDOMEN

These malformations point to very early disturbances or atypical growths in the normal course of fetal development. The umbilicus, the communication between the maternal and the fetal organism, is the portal through which the latter is nourished, and it is the last to close. Consequently it is here that disturbances of the final closure may easiest occur and these may then be complicated by secondary manifestations which always follow fissures and incomplete closures.

These congenital malformations may be logically divided into—

a. Those associated with the persistence of the ductus omphalomesentericus (including the pathology of Meckel's diverticulum).

b. Those associated with the formation of the bladder.

c. Those resulting from incomplete closure of the abdominal cavity or of the umbilical opening.

A. PERSISTENCE OF THE DUCTUS OMPHALOMESENTERICUS; MECKEL'S DIVERTICULUM

(See Knöpfelmacher, vol. i.)

Etiology and Pathological Anatomy.—In the eighth fetal week the canal which connects the intestinal tract with the vitelline membrane generally closes and becomes obliterated.

If the vitelline membrane is partially or entirely preserved, malformations may result which are in part visible outside the abdominal cavity at the umbilicus in the shape of a fistula or prolapse of the umbilical membrane, while another part can be observed within the abdominal cavity as a cord or canal running from the umbilicus to the small intestine. This canal may be obliterated wholly or partly, its umbilical end may completely disappear, and there remains in the abdominal cavity a diverticulum of the small intestine without outward communication which is known as Meckel's diverticulum.

If this canal is patent in its entire length there will be a fistula of the umbilicus, excreting mucus and also fecal matter, provided the lumen is wide enough.

If this canal has become obliterated before arriving at the umbilicus a cyst may be formed which often protrudes through the umbilicus later in life. The result is a cherry-red, more or less spherical tumor at the umbilicus with a central indentation from which the milky secretion, as described above, exudes (Fig. 22). The velvety condition of the surface, resembling mucous membrane, will easily lead to its recognition.

This anomaly, though slight in itself, may be fraught with serious consequences. If of sufficient calibre, the entire canal may prolapse,

drawing into it its intestinal end and leading to intestinal occlusion by invagination.

Other loops of the small intestine may slide from the abdomen into the folds of the prolapse, representing that pernicious combination of prolapse and hernia of the abdominal intestines which is occasionally observed in rectal prolapse (after Piéchaud).

Fig. 22.
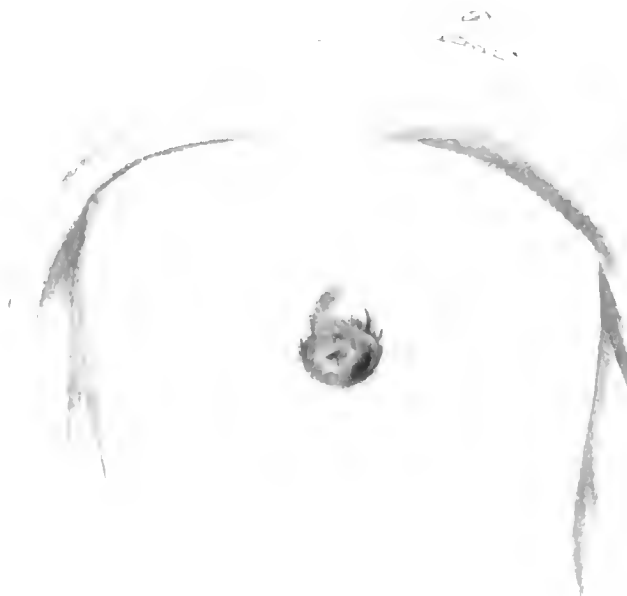
Prolapse of Meckel's diverticulum. Newborn child. A milky secretion exudes from the central indentation. The duct, removed by operation, was found lined with cylindrical epithelium.

If the canal should merely persist as a cord within the abdomen without giving rise to any disturbance, it may remain concealed for life. In transverse position, however, it easily leads to complications in connection with the movements of the intestine. In strangulation and torsion this canal has often been regarded as the cause.

Among 10,300 autopsies Turner found 81 cases with persistent vitelline membrane and a large number (360) in which there were pathological changes from this cause.

Disturbances may be caused also by a pedicular torsion of Meckel's diverticulum itself, the consequence of which is intestinal perforation and peritonitis (Fehre). Schwarz observed an intestinal stenosis due to prolapse of the diverticulum into the lumen of the small intestine. I myself have seen severe intussusception started by inversion of Meckel's diverticulum.

Another possibility is perforation in the diverticulum itself which may occur in the manner of perforative appendicitis. Impeded circulation, fecal stasis owing to occlusion of the lumen, may lead to ulcerations of the wall and perforation with all its consequences (Gebbele, Brentano).

FIG. 23.

Meckel's diverticulum chronically enlarged and perforated—a, discharge into the intestinal lumen; b, ulcerous perforation.

Illustrative case: A child one year and nine months old fell ill with symptoms of acute appendicitis. Vomiting, tenderness of the abdomen on the right side, distinctly palpable tumor, and fever. Laparotomy disclosed diffuse serofibrinous peritonitis of the superficial intestinal coils, the tumor itself being a growth the size of a child's fist with multiple adhesions to the neighboring loops and to the omentum. It was found on exposure that the growth was the enormously enlarged end of a free Meckel's diverticulum (Fig. 23). There was a gangrenous spot at the lower end where the perforation had taken place. The diverticulum itself was completely filled with ascarides, and its open end was totally occluded by a bunch of them. It was probably owing to this occlusion that stasis of the contents and tumefaction had resulted. After excision of the diverticulum the patient was cured.

Umbilical tumors, known as umbilical adenomata, may originate from the adenoid tissue of the diverticulum and its remnants.

The **diagnosis** of an open Meckel's diverticulum is very easy if fecal matter can be demonstrated in the secretion. But these cases are exceedingly rare. Examining the lumen with a sound, when possible, may facilitate the differential diagnosis from fistula of the urachus, the direction of the sound in the latter case being toward the base of the bladder. Acid reaction of the secretion points to fistula of the urachus, as does also the demonstration of urinary constituents.

Alkaline reaction of the secretion renders a rectal communication probable. Subcutaneous injection of methylene blue can be employed as an aid in diagnosis, as there would be blue coloration of the urine in a short time if there is communication with the bladder.

If there is only a short cul-de-sac or cyst the histological examination of their wall lining will in most cases have to be resorted to in order to decide their origin. Prolapse of the mucous membrane may occur in fistula of the urachus as well as in Meckel's diverticulum, although in the latter it is more frequent. A serious confusion occurs only when an umbilical adenoma is mistaken for a granuloma (umbilical fungus), but the central depression of the cherry-like growth always points to the presence of a fistular duct. The smooth consistency of the surface in prolapse and in adenoma distinguishes them from the raspberry-like surface of an umbilical granulation tumor. In any case precaution is necessary in excising larger growths of this kind, as there is a possibility of injuring a loop of the small intestine.

With ileus or symptoms of intestinal strangulation in young patients that are afflicted with other degenerative malformations, such as harelip, etc., the possibility of a diverticular band should always be kept in mind.

The **prognosis** is entirely dependent upon the complications already referred to, which may have been caused by the diverticulum.

The **treatment** consists in the extirpation of the open duct, of the cyst or the cul-de-sac. From a small incision along the mesial margin of the rectus muscle the entire duct can be easily removed as far as the intestinal wall. The stump is treated by invagination secured by purse-string suture.

The treatment of the other possible complications depends upon their nature in each case.

B. PERSISTENCE OF THE URACHUS; FISTULE OF THE URACHUS

Through patency of the allantoid duct, which likewise passes through the umbilicus, a fistular formation will develop at the umbilicus which secretes urine. It is lined with pavement epithelium. The fistula may be complete or end in a cul-de-sac at a distance, or it may lead to the

formation of a cyst within the duct which slowly grows and often perforates only later in life. As the contents are liable to infection, there may be a secretion of pus in the course of time.

The **diagnosis** has been already referred to when considering fistulæ of the vitelline membrane (Draudt).

The **prognosis** has to take into account the possibility of the bladder becoming infected, and difficulties in urinating as a result of inflammation of the cord which holds the bladder in position.

Operative **treatment** should not be undertaken until any existing inflammation of the bladder has subsided (v. Bramann).

Incision around the fistula, following up the cord to the neck of the bladder (where the cord generally widens out in conical shape and gradually merges into the bladder wall), excision, suture of the bladder, closure of the abdominal wall with drainage—these are the steps of the operation.

C. ABDOMINAL FISSURES
(See Langstein, vol. iv.)

According to the structure of the embryonal intestine, which originally consists of a broad open groove, the embryonal body may remain entirely or partially open if disturbances of development set in. This may be occasioned by the already mentioned anenergetic arrest of degeneration, by exterior traumatic causes arising from the uterus and the investing membranes of the ovum, or by interior pathological processes on the part of the fœtus. According to the extent of the malformation or to the period of its onset, the organs contained in the abdominal cavity may participate in the fissuration.

The highest degree is—

1. Fissure of the Abdomen with Exstrophy of Bladder and Intestine

This means patency of the entire abdomen. The primitive intestinal structure, likewise the bladder, the pelvic ring, and the sexual organs remain fissured (Stangel, Boekenheimer).

These cases, not being viable, have no surgical interest.

A lesser degree of defect occurs in the rare absence or fissure of the sternum, also in fissures of the thorax and diaphragm.

Hernia of the umbilicus and umbilical cord, which from their history of development belong to this chapter, have been incorporated in the section on Herniæ to facilitate the general survey.

2. Abdominal Fissure with Vesical Exstrophy

Of the abdominal fissures occurring below the umbilicus, ectopia vesicæ is the most important.

The **etiology** is to be sought in an arrest of development. There is frequent simultaneous occurrence of other malformations.

According to some authors (Ahlfeld, Bartels) it originates from the bursting of the allantois (the primitive bladder), caused by excess of secretion at a period when the lower aperture for its outflow had not yet formed. Other investigators look upon this malformation as a pure arrest of development analogous to the other fissure formations.

Symptoms.—The abdominal walls below the umbilicus often drawing the latter with them, diverge, forming a fissure of varying width and length, from which mucous membrane protrudes. This is always moist, has a red lustre and many folds, and is contracted into ridges. This is the mucous membrane of the bladder. Its margins gradually merge into the outer skin, with a scar-like appearance.

FIG. 24a.

Ectopia vesicæ, epispadia totalis, cryptorchism. Boy eighteen months old. The ridge-like mucous membrane has the character of a cauliflower tumor. Both testes lie in the abdominal cavity, the inguinal ring is open at both sides, the symphysis fissured.

The mucous membrane is very vulnerable, tender on palpation, and bleeds easily. Under the influence of abdominal pressure it may be forced still further out of the abdominal cavity, while with relaxed abdominal walls it may almost entirely recede within the abdomen.

In very young infants it is still possible to straighten out the ridge-like mucosa to a certain extent, but in older children it has already assumed the character of a cauliflower-like tumor owing to secondary processes (Fig. 24).

In its lower half it is possible to recognize the orifices of the ureters, from which urine is ejected in jets.

The posterior wall of the bladder, with the trigonum, is visible and the anterior wall of the bladder is absent, as development has been arrested owing to persistent patency of the fissure; and after the gaping

of the cloacal membrane the mucosa of the primitive vesicular structure retains its protruding position. These outwardly visible changes are usually supplemented by patency of the osseous pelvic ring. The symphysis pubis is not united.

The fissure may also extend to the urethra. In male children there is a rudimentary penis with total epispadias. The scrotum is fissured, and the testes are usually retained in the abdominal cavity (cryptorchidism).

Similar changes occur in the female genital organs: open, groovelike urethra, fissure of the labia majora and minora, owing to absence of the commissure, and fissure of the clitoris. (See Female epispadias.) The perineum is considerably stunted and the anal orifice is consequently displaced forward.

The symptom-complex may vary in different ways. Epispadias may have the appearance of fissuration of the lower part of the rudimentary bladder, just as a wide fistula of the urachus may be considered a partial upper vesical fissure.

The subjective symptoms result from the anatomical conditions. Continuous dribbling of urine causes eczema of the skin and excoriations, with the consequence that the unfortunate victim is quite impossible as a member of human society. The genital organs are stunted.

The **prognosis** is rather doubtful, and a large percentage of children no doubt perish from septic and pyemic affections (nephritis) owing to the difficulties of proper nursing. Nevertheless, the literature contains many cases in which the deformity was relieved by operation after the twentieth year of age.

The **treatment** endeavors, in the first place, to relieve the tormenting symptoms, which consist chiefly in the great vulnerability of the exposed mucosa and in incontinence of urine.

There are two different methods to follow: (1) Dissecting the mucous membrane of the bladder and constructing a new bladder, covering up the defect with a flap of the skin and establishing communication between the new bladder and a urethra which has likewise to be specially formed; (2) implanting the ureters into the intestinal tract, thus forming an artificial cloaca.

The first method was proposed by Roux and followed out by Holmes and Wood, the object being to close the bladder anteriorly by double skin flaps. The method reached its zenith under Passavant and Trendelenburg, who dissected away the protruding mucosa and united the parts, while the two halves of the gaping symphysis were approximated by suture after cutting through the sacrococcygeal commissure. This approximation can also be effected by orthopædic apparatus (Wilms). Communication will then be effected between the new-formed bladder

and the groove of the penis, or the new-formed urethra, as the case may be. The abdominal wall is closed over the new-formed bladder.

This method creates natural conditions with the exception of urinary incontinence, which usually persists in the absence of a functioning sphincter, so that patients are obliged to wear a urinal. Berg's suggestion of the extraperitoneal insertion of an intestinal coil complicates the operation.

The results reported by Trendelenburg are very encouraging, but the danger of persistent incontinence, the difficulty of creating a suffi-

Fig. 24b.

Ectopia vesicæ. Epispadia, cryptorchism, displacement of umbilicus, absence of symphysis.

ciently large hollow organ, and the large number of complicated plastic procedures, will still urge operators to resort to the expedient of an artificial cloaca.

The implantation of the ureters into the groove of the penis (Sonnenburg, Segond) has likewise been abandoned as unphysiological; so has the vesicorectal fistula proposed by Roux.

The most favorable results have been achieved by Maydl's operation. Omitting the details which are described in his original work, it consists in the dissection of the trigonum and its implantation into the rectum (mortality 25 per cent.).

The method entails many technical difficulties and dangers. The rectal implantation involves a rotation of the trigonum by 180 degrees around a frontal axis, which may easily lead to kinking and occlusion of the ureters. Besides, ascending infections often cause pyelonephritis.

Preference has been given more recently to the rectum over the sigmoid flexure because it is usually free from fecal matter and the sigmoid flexure may do service as a reservoir. Furthermore, the implantation may be effected extraperitoneally, which would diminish the danger of peritonitis in the presence of a suture fistula (Garré). By excluding a portion of the intestine from the fecal circulation through transverse resection and lateral anastomosis, the danger of ascending pyelitis was sought to be restricted. The upper end is closed and the trigonum sutured into the distal end (Borelius, Müller, Gersung, Berglund).

Direct implantation of the ureters into the intestine, as proposed by Subbotin, is sure to lead to infection of the kidneys, owing to the absence of a valvular apparatus of the trigonum.

Summarizing the various methods of operation, they all involve rather extensive surgical interference and prolonged operation. This refers to both the Trendelenburg method and to any of the modifications of Maydl's operation. The easiest and least dangerous operation would be implantation of the trigonum into the groove of the penis, but even this would condemn the patient to continuous incontinence and its sequelæ.

In any case all extensive operations should be postponed until advanced childhood, but in the interim the soil may be prepared for future operation by wearing compression apparatus (Trendelenburg, Wilms).

II. CONGENITAL DEFORMITIES OF THE GENITAL TRACT

1. EPISPADIAS
(See Langstein, vol. iv.)

Epispadias is a fissure of the lowest part of the bladder or of the urethra, caused by premature arrest of the advancing growth of the abdominal walls (Kaufmann).

According to whether the fissure involves the entire urethra or only parts of it, we distinguish—

1. Fissure of the vesical neck.
2. Epispadias of the penis.
3. Epispadias of the glans.

The first form commences close to the fissure of the bladder. The entire urethra is fissured, the mucous membrane is in flat tension and at the symphysis passes direct into the bladder by an infundibular deepening; and if there is simultaneous fissure of the symphysis, the bladder may be readily seen.

The corpora cavernosa are divided, the glans is imperforate and solid, with a groove-like depression. The prepuce extends beyond the stunted penis at the ventral side in the shape of an apron (Figs. 24a and 24b).

In the second form the fissure extends only to a narrow infundibulum at the mons pubis, in which the groove gradually disappears under the unfissured symphysis.

In the third form, which is very rare, only the glans has a groove, while the proximal part of the urethra is intact.

The subjective symptoms depend upon the extent of the deformity. In fissure of the neck of the bladder the sphincter is generally involved, with consequent incontinence.

In minor degrees, too, micturition and later sexual function are interfered with.

Similar conditions have in rare cases been found in the female, and are characterized by arch-like divergence of the labia majora and minora, absence of the corresponding commissure, and fissure of the clitoris. The infundibulum which deepens the arch-like distention of the labia majora leads directly into the bladder, the mucosa of which is often prolapsed. The outward changes are not very noticeable to the layman, and it is often only the concomitant incontinence that causes parents to consult a physician (Figs. 25a and 25b, Plate 3).

The **treatment** should endeavor to bring about normal conditions as far as possible. The groove is transformed into a canal by a plastic flap (Duplay, Thiersch).

Thiersch first provides a urinary fistula at the perineum (a buttonhole) for the urine to flow off, thus allowing the field of operation to have undisturbed rest. This preliminary operation has again recently been strongly recommended by Vulliet.

Thiersch transforms the groove of the glans into a canal by dividing the glans into three parts through two longitudinal incisions, suturing the middle part to form a canal which he embeds deeply into the tissue, and closing the two lateral parts over it. By an appropriate plastic flap the groove of the penis is changed into a canal, and both canals are united with the aid of the prepuce. In establishing communication between the urethra and the neck of the bladder, flaps are used taken from the skin of the abdomen.

Beck proposed a similar method resembling his operation for hypospadias. The mucous membranes of the groove of the penis and of the neck of the bladder are dissected free, then united by a purse-string suture, drawn through the tunneled glans and fixed in that position.

I have succeeded in correcting female epispadias in a similar way, by dissection of the mucous membrane of the visible vesical neck,

PLATE 3.

FIG. 25a —Epispadia in the female. Girl six years old. Archlike commissure, the fundus of the fossa leading
into the bladder'

FIG. 25b.—The labia majora are drawn apart showing the libia minora, which meet in a flat arch   The
fissured clitoris is embedded in the labia.   The neck of the urinary bladder is very wide, and the prolapsed
vesical mucosa is visible at the fundus.

reformation of the large and small commissures by rotation of the new-formed urethra through 90 degrees, and fixation of the latter in the angle of the commissure, enlarging at the same time the urethro-vaginal septum, with resulting continence of several hours.

2. HYPOSPADIAS

Pathological Anatomy.—Hypospadias is much more frequently met with than epispadias, the ratio being 150 : 1. In this deformity there is a groove-like opening of the urethra on the under side of the penis.

According to the extent of the fissuration, the urethra terminates at various atypical places in the genital organ.

This fissuration is caused by non-union or incomplete union of the groove of the mons pubis. Its origin dates from a much later period

Fig. 26.

Hypospadia perinealis (scrotalis) The urethra is fissured beyond the scrotum, and the fissured scrotum is only indicated by integumental folds. There are also cryptorchis, curvature of the penis, and apron-like prepuce.

of embryonal life than that of epispadias, which we must attribute to the first few weeks—the period when fissure of the bladder is assumed to occur. This would also account for the greater frequency of hypospadias.

According to the position of the secondary urethral aperture we distinguish—

    a. Hypospadias of the scrotum (Fig. 26).

    b. Hypospadias of the penis (Fig. 27).

    c. Hypospadias of the glans.

In the first form, which is the most severe and also the rarest, the fissure or non-union extends not only to the urethra, but frequently also to the scrotum. The further back toward the perineum the urethral

aperture lies (perineal hypospadias), the more extensive is the fissuration of the genital organs, which in the most pronounced cases approaches the female type (pseudo-hermaphroditism). The completely divided scrotum resembles the labia majora, encircling at the anterior commissure the clitoris-like imperforate penis (Fig. 26). The latter is usually stunted, with a downward curve and a rudimentary formation of the apron-like prepuce.

In the second form, the urethral orifice is situated beyond the scrotum toward the coronary sulcus. In rare cases there are two orifices, or fistulae.

FIG. 27.

Hypospadia penis. The scrotum has indications of a division, the medial raphe being retracted. The urethra terminates at the scrotal root of the penis.

In the third form, only the glans is imperforate, and the urethra as a rule opens in the vicinity of the frenum or at its physiological place. In many cases the normal orifice is indicated by a fossa navicularis, which, however, ends in a cul-de-sac or communicates with the urethra by a very fine canal. Micturition takes place through the fistular opening, from which a sagittal fold of skin runs to the scrotum.

The symptoms consist principally of the disturbances of micturition and of the impediment to the genital function, which may from mechanical causes give rise to sterility.

The treatment endeavors to establish normal conditions. This is accomplished partly by detaching and straightening the penis and partly by the formation of a new urethra and burying it beneath the skin surface.

The plastic operation of Duplay (Thiersch), which has already been mentioned, is of importance, but better results are obtained by stretching the urethra and tunneling the glans (v. Hacker, Beck).

The first step is to expose the existing urethra on the ventral side by a longitudinal incision and to dissect it loose, together with the corpora cavernosa; then the glans is perforated with a blunt instrument or by the cross-puncture of a scalpel, after which the loosened urethra is drawn through the perforated glans. The terminal part of the urethra, which is usually stenosed, is incised or freshened and sutured to the mucous membrane of the glans.

According to v. Hacker it is possible to stretch the urethra by twice its lumen without danger, and this is an excellent way of creating nearly normal conditions in hypospadias of the glans. It is also possible to change excessive retrodisplacement of the urethral orifice and to transform the perineal form into penile hypospadias. The remaining part might be tunneled by other kinds of plastic operations, possibly by insertion of tubes of blood-vessels united with the urethra, which should be placed as far forward as possible.

It is important to avoid excessive tension in order to preserve the suture. Bardenheuer suggests in this connection to incise the regional skin around the urethral orifice and to place the same anteriorly.

A permanent catheter should be worn for some time after operation, but as this is both inconvenient and painful, aside from its unfavorable influence upon the healing process, Vulliet's method of resorting to a temporary perineal button-hole might be considered.

The time for operation should be selected in accordance with the condition of the patient. In any case it is advisable to wait until the parts have grown to larger dimensions. On the other hand, it should be considered whether growth might not exaggerate the deformity (kinking). The middle part of childhood, from the eighth to the twelfth year, would be the best time for operation, if the condition admits of waiting. In our cases the best results were attained in operations after the sixth year.

Congenital occlusions and stenosis of the urethra are rare occurrences and likewise attributable to arrest or disturbance of development. In a symptomatic respect they entirely resemble the acquired changes of this kind and should be treated in accordance with general surgical rules.

3. PHIMOSIS

(As to origin and symptomatology of phimosis, see Langstein, vol. iv.)

The **treatment** of phimosis should be operative, provided there is any cause for interference at all. If there is merely an epithelial adhesion without any particular stenosis of the preputial orifice, it will in my

opinion only be necessary to break up the adhesions if there is irritation
from partial retention of smegma. By connecting the preputial sac with
an irrigating tube, the epithelial adhesions can be removed by the pres-
sure of the inflowing liquid.

A rough method of breaking up the adhesions causes unnecessary
pain and relapses from subsequent complications. The bloodless dis-
tention of the preputial ring with a dressing forceps is very painful and
must be frequently repeated. Tears may occur, leading to scar formation
which will render a radical operation necessary later on.

All the operations for the removal of this deformity are devoid of
danger, rapid of execution, and free the little patient from his troubles
in a relatively short time. They do not attract his attention to this
region, as is the case with slow and long-continued treatment.

In regard to the time for operation, it may again be stated that
epithelial agglutinations undergo a physiological cure in the course of
the first year of life. Previous to this time there is a kind of physiolog-
ical phimosis; the preputial ring is still narrow at this period, but is
spontaneously stretched later by the growth of the glans.

In the first few years of life no surgical interference is necessary
except in impeded micturition and inflammatory processes in the pre-
putial sac caused by decomposition and infection of smegma (balanitis).
Partial or complete balanitis naturally requires the retraction of the
prepuce and thorough cleansing of its sac. If this cannot be accom-
plished in a bloodless and gentle way, operation will have to be resorted
to. Cicatricial changes and continuous excoriations at the preputial
ring, especially in the presence of a long, tubular, hypertrophic prepuce,
require radical correction. It should also be remembered that in an
individual with tendency to hernia increased abdominal pressure in
urination favors a protrusion of the bowels into the preformed hernial
sac. (See Herniæ.)

If there are no urgent indications of this nature and the urinary flow
is not impeded, the plastic operation may be safely deferred until the
approach of maturity.

In very young children a method of operation should be selected
which will give the desired result in as rapid and simple a manner as
possible.

Wrapping in a sheet and light ether anæsthesia should be sufficient
in infants; local anæsthesia in older children. The majority of cases in
infants have a long, hypertrophic prepuce, and for these I prefer oblique
parallel circumcision to other and more complicated methods.

Similarly to ritual circumcision, the prepuce is pulled forward, the
glans pushed back into the preputial sac, and the entire cicatricial ring
severed with one cut of the scissors in a strongly oblique direction and

parallel to the sulcus coronarius. If the inner layer is much constricted and adheres to the glans, it should be incised from the dorsal side and gently separated. The two layers are precisely united, care being taken here as well as at the union with the lip not to touch the parts with sharp pincettes, as this may cause pressure necrosis and gangrenous margins of the easily vulnerable mucous membrane. Tying the sutures too firmly will favor œdema, which is a disturbing factor. The bandage should consist of sterile gauze and be held in position by a triangular napkin.

We have come to discard any other kind of fixation, such as the gauze cigarette, which is tied alongside the wound, because they are constantly saturated with urine, and under the influence of continuous moisture the suture might cut through the skin and cause an infection of the wound. Nurses are instructed to use dressing forceps when changing the gauze dressing so as not to touch the field of operation with their fingers.

I consider this method of after-treatment preferable, especially in small children, while in older ones other kinds of permanent bandages, adhesive plaster bandages, cigarette bandages, etc., may facilitate the treatment of out-patients.

When the prepuce is short and very narrow, recourse may be had to the radical method of ritual circumcision, carried out on the principles above explained, or the preputial opening may be found capable of distention by longitudinal incision of the dorsum.

The well-known method of Roser is the simplest. Both layers are cleft at the dorsum over a grooved director. At the incision of the inner layer a small flap is formed and sutured into the traumatic angle of the outer layer. The resulting lateral tabs being unsightly, various improved methods have been introduced during the last few years which answer all requirements of function and æsthetics.

It is certainly advisable for the general practitioner to avoid complicated methods. The healing of a wound is much more easily disturbed and is much more unpleasant at this site than at others, and these possibilities are disproportionately increased by the complexity of the incision.

Paraphimosis, or the retention of the preputial ring at the sulcus coronarius, will require immediate interference more frequently than phimosis. In most cases the prepuce can be retracted. Holding the penis with the first and second fingers behind the ring and increasing pressure by one or both thumbs upon the œdematous glans, will accomplish the result in slight cases.

If the constriction has existed for some time, and there is danger of gangrene or of a deep groove owing to the ligation, harsh manipulations should be avoided. The constricting ring is incised after a grooved director has been inserted.

A congenitally short frenum need give rise to therapeutic interference only at the age of puberty.

A few more anomalies of the female genitalia will be dealt with later on (p. 97).

III. CONGENITAL DEFORMITIES OF THE RECTUM

1. ATRESIA ANI ET RECTI

(See Fischl, Deformities in the Region of Rectum and Anus, vol. iii.)

Pathological Anatomy.—A rather frequent arrest of development, reaching back into a very early period of embryonal life, consists in disturbances connected with the physiological structure of the rectum.

From the preceding description of the history of abdominal development, the close relations between the development of the rectum and that of the urogenital system are apparent. Although it is not an easy matter to explain these anomalies in each case from their natural history of development, I believe it is still clearer and more logical to explain the abnormal connection, positional changes and communications of the organs by assuming that, similarly to cranial processes, biological mnemonics have failed, whether from deficient power of fetal development or from individual pathological conditions of the mother, instead of vaguely holding purely mechanical and undemonstrable causes responsible, such as the bursting of preformed organs and inflammations of the well-protected primitive nuclear structure. (See Läwen, Rotter.)

Many experiments on the lower species of vertebrate animals have demonstrated to what kaleidoscopic changes, and subsequent spontaneous correction of growth, injuries to the ovum may lead.

An imperforate anal membrane leads to the condition called *atresia ani*. At the physiological site of the anus the skin is either quite smooth (Plate 4, Fig. 28) or, as is usually the case, there is a small fossa or fold of the skin which points to the anal spot (Plate 4, Fig. 28; Plate 5, Figs. 30a and 30b). Above this closed anal membrane the rectum terminates like a cul-de-sac. Again, the external anal orifice may be present, the invagination of the ectoderm having taken place, while the deep part of the membrane has no orifice (*atresia recti*). If both structures are closed, the layer between the external integument and the blind rectum may attain considerable thickness. At the sacrum, and higher, the sigmoid flexure may terminate in the shape of an ampulla (*atresia ani et recti*). (See Fig. 29, Plate 4.)

In these serious forms the pelvic outlet is likewise changed, the tuberosities of the ischium being approximate because of the absence of the rectum.

Through the relations of development at the pelvic extremity abnormal orifices and communications may occur; a persistent com-

PLATE 4.

FIG 28.—Atresia ani The skin passes over the anal spot without a fossa, but with distinct raphe. The skin is bulged out by the ampulla. The scrotum is divided. Successful operation.

FIG 29 Atresia ani et recti The colon is enormously distended, the sigmoid terminates at the level of the first lumbar vertebra and is adherent to the vertebral column by a narrow tip.

munication between the anterior and posterior spaces of the cloaca causes the rectum to end in the bladder (atresia ani vesicalis); or, if the rectum should be formed later at the normal place, there may be a congenital fistula between these two organs. If the perineum is insufficiently developed, the rectum inosculates into the vestibulum (atresia ani vestibularis) (Figs. 30a and 30b, Plate 5).

The insertion of the female genitals between the structures of the cloaca also leads to abnormal orifices and fistular formations (atresia ani vaginalis).

These anomalies may also complicate the structure of the male genital organs. The rectum may communicate with any part of the urethra either directly or by a fistula (atresia ani urethralis) (Fig. 31, Plate 5).

These fistular ducts may also open outward at atypical places, as for instance under the penis and at the scrotum. Stieda explains these fistulæ as secondary formations.

The **symptoms** causing these anomalies vary with the gravity of the anatomical malformation. The complete superficial closure of atresia ani is usually noticed at once, since it leads shortly after birth to manifestations of intestinal occlusion, restlessness, and vomiting. The retained meconium is soon infected from the mouth, decomposes and gives rise to general peritonitis.

If there are fistulæ with an external opening, the conditions described may be less pronounced or entirely absent.

The most favorable conditions exist in anovestibular atresia (Fig. 30, Plate 5), the opening of the rectum into the vestibulum being of considerable width. Corresponding to the embryonal displacement there is a functioning sphincter internus, so that cases have occurred in which individuals only learned of the abnormal condition at an advanced period, perhaps on the occasion of childbirth.

In the presence of narrow fistulæ conditions are much more aggravated, the rectum being stenosed either in its entire length or at either end, or it may communicate externally at the normal site through a tubular fistula. Since only fluid or mucous fecal matter can pass through these ducts, there is again intestinal atresia with its sequelæ.

The **prognosis** is worst in total or partial communication with the bladder. In most cases infection of the urinary passages will be almost unavoidable. Page's case, of a man who up to the age of 54 evacuated the fæces through the urethra, is unique in the literature. In the period of rapid infantile development the mucous membrane of the bladder certainly seems to adapt itself to some extent to abnormal contents, and in one of my cases of ano-urinary atresia the anomaly had existed for several weeks without giving rise to any disorder of the bladder, the

favorable factors apparently being that the child was breast-fed and that the abnormal communication extended not higher than the urethra.

If the urine is occasionally clear and at other times mixed with fecal crumbs, the diagnosis of atresia ano-urethralis is probably correct; if it is more or less homogeneously mixed with faeces, it would rather point to atresia vesicalis. This differentiation, however, does not always apply, Loetsch, for instance, reporting a case of a wide communication between rectum and bladder, verified by operation, in which at times perfectly clear urine was evacuated. On the other hand, minute fistulæ may, under the influence of considerable pressure of meconium, cause permanent turbidity of the urine, although a communication with the bladder need not necessarily be present (Fig. 31, Plate 5).

Treatment.—This anomaly always requires operative treatment, and the time for carrying it out will depend on the gravity of the case.

The relief of total atresia is an emergency operation. The abnormal conditions should be relieved as rapidly as possible, before the sequelæ of intestinal atresia render the prognosis of an operation unfavorable. In other anomalies consisting in abnormal fistula ducts the operation may be deferred until the patient is in a sufficiently favorable condition. Whenever there is communication with the bladder the danger of infection of the urinary ducts should never be overlooked.

The operation for atresia ano-vaginalis should be deferred until a suitable period if the communication is sufficiently wide.

The normal procedure in total atresia of the anus consists in searching for the rectum through the perineum. If there is only an epithelial covering and the rectum, filled with meconium, shines through a thin separating layer, this may be bluntly incised.

Should the layer be of greater thickness, any kind of instrumental perforation should be avoided. The child is wrapped up in the laparotomy position and lightly etherized. Deep anæsthesia is inadvisable, since the crying and straining under light anæsthesia bulge out the rectum considerably, facilitating its localization.

A median incision from the coccygeal apex is made through an anal fossa if possible, and beyond anteriorly, exposing the intestinal structure as the incision deepens, and keeping the incision carefully in the median line. The operator advances along the anterior surface of the sacral bone, paying careful attention to the position of the urinary bladder. A previously inserted catheter will furnish information as to its localization. It is of importance always to keep towards the anterior surface of the sacral bone, because in this way the rectum will always be found even in high position, without opening the peritoneum (Fig. 29, Plate 4). The vicinity of the ampulla is recognized by the bluish transparency of its contents. The rectum is bluntly dissected from its sur-

PLATE 5.

Fig. 30a.—Atresia ani vestibularis. Eight-months-old child. The rectum with the sphincter internus connects with the vestibulum (a). At the place of the anus there is a protuberance of the skin, behind which there is no bulging of the ampulla either visible or palpable.

Fig. 30b.—The same child, six months after operation. Retracted anus at the normal place, sphincter acting. The duct leading to the vestibulum is obliterated.
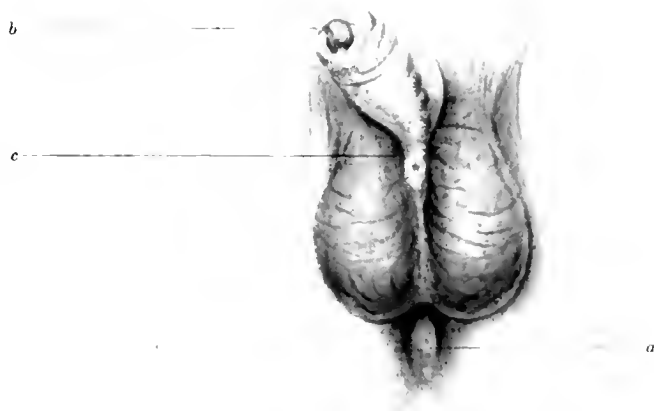
Fig. 31.—Atresia of anus and urethra. Six-weeks-old child. At the place of the anus there is a protuberance of the skin. The fæces are evacuated through the urethra (b) and through a scrotal fistula (c) at the root of the penis. Successful operation.

roundings and so far mobilized that it can be pulled out to the outer surface of the skin, or as near thereto as possible. Care should be taken not to injure the urinary ducts and the umbilical veins. The traumatic opening having been carefully tamponaded, the ampulla is opened by an incision corresponding to the normal width of the rectum and its usually bulky contents evacuated. The mucous membrane is sutured to the outer skin and the deep traumatic funnel closed by figure-of-eight sutures. If it is possible to bring the unopened ampulla to the outer skin without evacuating it and to suture it in that position to the skin, this would, of course, be preferable to a primary incision, but this can only be done in part of the cases owing to the great tension. Buried sutures are best avoided in this unsafe region, but dissected muscles, if any, should be carefully sutured.

In many cases there is a partially formed external sphincter ring, and this should be carefully searched for, as the anal orifice may be inside of it (Fig. 29, Plate 4).

If the rectum cannot be located by advancing up to the promontory, it would be permissible, following the procedure of McLeod, to resort to laparotomy on the left side, making the smallest possible incision, through which the rectum may be pushed toward the perineal incision.

In cases where even this procedure does not lead to the desired result, the creation of an artificial anus in the lateral abdominal incision is the last, though very undesirable resource, its function leaving very much to be desired.

In an eight-months-old child with anus vestibularis I made an arch-like incision around the anal fossa which showed outwardly visible function, dissected the rectum with its funnel-shaped vestibular end from its surroundings, perforated the anal fossa and pulled the rectal tube through the existing sphincter ring, thus following a process similar to that in hypospadias. Then followed closing of the pelvis by perineal plastic. The operation was followed by complete function which was verified six months later (Fig. 30b, Plate 5).

The same result was attained in an infant (Fig. 31, Plate 5). In all cases, however, the rectum should lie close to the skin incision without tension, as otherwise the sutures will cut into the parts and the rectum retract into the traumatic funnel, the anal portion developing into a cicatricial canal which would easily cause symptoms of stenosis. Should there still be any accessory fistular ducts, these are best treated by open incision, although they would soon become obliterated if fecal matter no longer passes through them (Fig. 31, Plate 5).

The results of this proctoplastic method (Dieffenbach) are far more favorable as to mortality than operations through the abdominal cavity,

the proportion of recoveries being from 22 to 65 per cent. (Ashhurst). Of course, the unfavorable statistical figures for the abdominal operations are not quite fair, because from the first the cases submitted to them are grave and unfavorable, but prolonged operations in the abdominal cavity, such as are always involved in plastic procedures, are well known to be borne badly by infants, quite aside from the fact that the deep anæsthesia required is another injurious factor.

Note.—For other congenital dilatations and constrictions of the intestine, such as Hirschsprung's disease and intestinal stenosis and atresia, see R. Fischl, vol. iii. For their surgical treatment, see "Intestinal Operations."

IV. HERNIÆ

If any of the contents of the abdominal cavity enter a pocket of the parietal peritoneum and pass through the abdominal walls, we have a condition called hernia. A hernia is therefore always covered by peritoneum and also by at least the external skin, or amnion, as the case may be.

Etiology and Mechanism of Development.—We are justified in regarding all herniæ in children, with very few exceptions, as congenital. In all cases existing fissures or gaps have failed to close in embryonal life or there is at least considerable weakness in these places owing to retarded closure or insufficient development of the closing elements.

There is really no difference in principle whether there is a fissure such as a harelip that has remained open instead of closing in early fetal life, or a canal which should have become obliterated at the termination of the embryonic period, such as the inguinal canal, or which should have closed immediately after birth, such as the umbilical ring.

The frequent simultaneous occurrence of herniæ and other congenital defects, and the patency of all hernial portals especially in prematurely born children, should suggest the idea that in herniæ we have to deal likewise with a deformity that has resulted from a deficiency in the energy of development.

Herniæ are especially frequent in degenerate populations, and are hereditary in so far as they are frequently present in the same family, particularly in such families where other degenerative manifestations, congenital deformities, physical inferiority, chronic intoxications, or rachitis, play an important part. From this point of view the assumption that in children nearly all herniæ are of congenital origin seems fully justified, the more so as in the forensic criticism of herniæ in adults the opinion is constantly gaining ground that at least the hernial tendency is congenital (Hansen) and that acquired herniæ are very rare.

1. HERNIA OF THE UMBILICAL CORD (HERNIA FUNICULI UMBILICALIS)

(See Abdominal Fissures. Also Knöpfelmacher, vol. ii.)

In the early embryonal period, before closure of the abdominal wall, the bowels lie as it were outside the abdominal cavity, the abdomen closing later through the two sides approaching each other. Simultaneously the relatively broad communication between the intestine and the vitelline membrane is reduced. According to Ahlfeld, the absence of this reduction prevents closure owing to the persistent traction of the cord. The bowels, which lie as it were outside the abdominal cavity, remain covered by the peritoneum and appear in the structure of the umbilical cord in the shape of a hernia. The rôle played by Meckel's diverticulum probably does not differ from that of the amniotic

FIG. 32.

Hernia of the umbilical cord. Small hernia, with distinctly visible line of demarcation and easily detachable amnion. Cured after Olshausen's method.

cords in harelip. It was, of course, always found present in early disturbance of development, and was then looked upon to explain the condition.

The **anatomy** accords with the history of development. The tumor varies in size, and is situated at the umbilicus, from which it directly passes into the umbilical cord. The external covering resembles the amnion of the cord, and is transparent and macerated at various places, as if it has been present for a long time. There is a strongly vascularized line of demarcation between the amnion and the outer skin (see Spina bifida), while in other cases the skin extends like a tube over the tumor which then looks pedunculated. In the latter forms the hernial contents are but slight, consisting, for instance, of an intestinal loop, omentum, etc. (Fig. 32).

Underneath the amnion are remnants of the gelatine of Wharton. This covers a membrane consisting of peritoneum in those cases which have originated during a late fetal period, while in those herniæ of the umbilical cord which date from a very early disturbance it may be designated as primitive membrane (Rathke). The latter membrane is distinguished from the peritoneum by the absence of blood-vessels.

FIG. 33.

Hernia of the umbilical cord. Large hernia, with hepatic lobe protruding, but reducible. Cured by radical operation.

The hernial contents consist of intestinal loops, in some cases even the liver, while very often there is a pedunculated middle hepatic lobe (Fig. 33). In other cases again there are but few intestinal loops, in a few others only a somewhat enlarged Meckel's diverticulum, giving the cord only a slightly distended appearance, so that when the cord is ligated the diverticulum may be tied off with it.

The **prognosis** of unoperated hernia of the umbilical cord is absolutely unfavorable, a great number of the children dying immediately after birth from bursting of the gelatinous wall of the growth. In other

cases death is soon caused from infection of the tumor walls and exten-
sion of the infection to the hernial contents.

Treatment.—Nothing but immediate operation can save the child,
spontaneous cure by scar formation having been observed only very
rarely (Sittler).

Small, pedunculated herniæ were formerly treated by subcutaneous
ligature, but this is objectionable because of the danger of ligating the
intestine at the same time; at any rate, the hernial sac should be opened
and examined before finally tying the ligatures.

In very early cases, however, where the hernia is not excessive, I
can warmly recommend Olshausen's method. An incision is made in the
healthy skin around the hernia, after which the amnion, if still in a fresh
and non-desiccated condition, can be easily detached from the inner
membrane in the layer of Wharton's gelatine. In this way it is possible
to reduce the hernia and close the skin over it without opening the
peritoneum.

This, however, is possible only in small herniæ, while in larger ones
it is necessary, according to Lindfors, to open the hernial sac and reduce
its contents. In prolapse of the liver this operation presents great
difficulties, especially as the hepatic lobe is sometimes adherent to the
hernial sac and the small capacity of the abdomen is unable to accom-
modate the intestines. If it is possible to decide that the prolapsed part
of the liver is merely a middle lobe, it may be possible to dissect it off
with a Paquelin knife, thus rendering the hernia reducible (Zillmer).

The principal rules for operation are

1. Operate as early as possible.
2. Operate as rapidly as possible.
3. Use the simplest possible method.

The danger of infection is one of the reasons why complicated
operations should be avoided, since it is impossible to disinfect thoroughly
the tumor walls. The operative statistics grow worse with the age, the
size of the tumor, and the quantity and kind of the hernial contents.

2. UMBILICAL HERNIA

(See Knöpfelmacher, vol. ii.)

Etiology.—The abdominal walls become closed before birth, with
the exception of the ring that must remain open for the umbilical vessels
to pass through. After the cord has fallen off and the umbilical vessels
have become obliterated, the gap becomes gradually smaller until it is
closed, although in nearly all infants during the first few weeks it can
still be felt about the size of a goose-quill. The fatty deposits which later
advance from all sides toward the umbilical ring play, in my opinion,
an essential part in its closure. In atrophic children umbilical hernia

is far more frequently present. This place certainly offers opportunities for eversion of the peritoneum; in fact, traction of the cord may have previously pulled it out into a funnel-shape. Crying and straining may facilitate forcing the abdominal contents into this funnel, and the same effect may have been produced by an abnormal position in utero. (Personal case.)

Pathological Anatomy.—The outward appearance of an umbilical hernia is that of an enlarged umbilicus which may assume varying dimensions. The wall consists of the cicatricial skin and the peritoneum, which, together with the transverse fascia, have prolapsed through the ring formed by the superficial fascia. Skin and peritoneum are closely

Fig. 31.

Umbilical hernia. Child four months old. Mushroom-shaped umbilical hernia. Umbilical ring over 1 cm. in diameter. Operative closure. Contents, omentum.

adherent to the tip of the tumor and in large herniæ may be reduced to the thinness of a transparent membrane. In most cases there is also a more or less extensive gaping of the rectus muscles.

The contents of extensive herniæ consist of the small intestine, and they are easily reducible by pressure, with the well-known gurgling sound. In small herniæ there is usually only a slip of omentum that prevents complete closure; it is generally adherent to the tip of the sac.

Symptoms.—An umbilical hernia rarely causes any disturbance in the well-being of the child. By exaggerated intra-abdominal pressure, however, it may considerably increase in size—for instance, in disorders of digestion and micturition (constipation, tenesmus, phimosis), coughing, and, later on, pregnancy—so that its earliest possible removal seems advisable. The earlier the operation, the more resistant will be the scar.

Treatment.—The open ring may undergo spontaneous closure, provided care is taken that the hernia never prolapses. This requires great attention on the part of the nurses, since a single prolapse will destroy the work of weeks in the endeavor to retain the hernia. If from

careless nursing or owing to the extent of the hernia permanent reten-
tion is not achieved after six weeks of palliative treatment, radical
operation should be resorted to.

The palliative measures consist in the application of adhesive band-
ages to exert pressure on the hernia and thereby prevent a prolapse. In
doing so, the natural process should be imitated, approximating the
margins of the hernia after its contents have been reduced.

The only way to effect this is the following: Hernia or umbilicus,
as the case may be, should be embedded between two longitudinal or
transverse folds of the skin and retained in this position by an adhesive
plaster bandage applied over the folds. It is not necessary to wind the
bandage around the body, as this would exert exaggerated pressure.

The insertion of pads into the bandage or the application of hard
discs to repress the hernia is not nearly so efficacious, because these
devices do not approximate the margins. The insertion of conical pads
is objectionable, because unphysiological. Leather or rubber bandages
obtain but little hold on the round body of an infant and will be found
unsuitable and useless with prolonged application.

The most practical kind of treatment is operative. With conser-
vative operation and a little practice it constitutes a mode of surgical
interference which is singularly free from danger.

It need only be considered that there exists a biological intention of
closing the ring and that nothing but the constant protrusion of the
contents prevents it. In the newborn, therefore, we may confine our-
selves to the closure of the hernial ring without resorting to any plastic
measures, which would unnecessarily prolong and complicate the opera-
tion on an infant.

My method of operating is as follows:

A very small, arch-like incision is made above or below the umbilicus,
not more than ½ cm. distant from the umbilical tumor, around which it
passes in the shape of a semicircle, half the circumference of the hernial
neck being exposed and the little flap turned up. The other half of the
hernial neck is loosened up with a blunt instrument, so that the entire
neck may be placed between the blades of an open pair of artery clamps
(Fig. 35a). The hernial sac is opened peripherally from the artery for-
ceps and near the skin; the top of the sac, which is always adherent to
the skin, is left attached; the peritoneal margins are ligated with clamps;
any contents that may be present are reduced, the sac is drawn tight,
and the artery clamps which were applied first are closed (Fig. 25b).
The sac is ligated peripherally from the clamp, the latter is taken off,
and the hernial sac sutured over the ligature, either longitudinally or
transversely. Large herniae, which are generally associated with a dias-
tasis of the rectus muscles, are treated by closing the raphe of the

rectus muscles, turning down the skin flap and closing the skin wound
with a few Michel clamps (Fig. 35c). The wound will heal in four days.
In six months the cicatrix will be so far retracted, together with the
umbilicus, as to be scarcely noticeable.

Extirpation of the umbilicus is in my opinion a grave error which
violates the principles of conservative and cosmetic surgery. It can
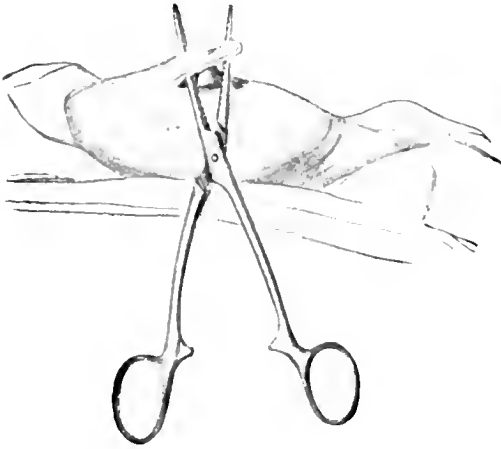
Fig. 35a.   Fig. 35b.
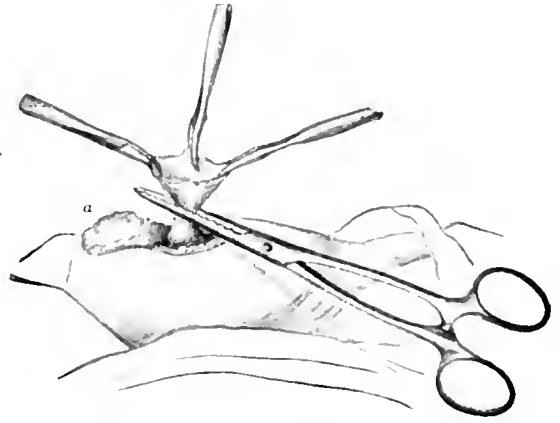
Fig. 35a.—Operation for umbilical hernia. First step: An incision has been made around the umbilical
hernia in the shape of a semicircle; the upper circumference has been circumvented with a blunt instrument,
and an open pair of artery clamps inserted.

Fig. 35b.—Operation for umbilical hernia. Second step: The hernial sac has been opened, its top remain-
ing adherent to the skin flap; the latter is folded back (a). Pincettes are applied to expose the hernial sac for
inspection, the contents are reduced, the forceps first applied are closed, after which ligature of the hernial
sac can be performed.

Fig. 35c.

Operation for umbilical hernia. Third step: After ligature of the hernial sac, its peripheral part is dis-
sected off, the hernial ring is closed lineally, the skin flap with the navel is replaced, and the wound closed with
metal clamps.

easily be dispensed with and prevents the unæsthetic appearance pro-
duced by absence of this cosmetically important part.

Ligation of the hernial sac, without opening it, involves great danger,
because, as previously mentioned, a portion of the omentum, adhering
to the top of the sac, may have been the cause of preventing spontaneous
closure of the ring. Ligation would certainly cause it to adhere again
and, besides, might induce a number of complications resulting from
intestinal fixation in the hernial sac.

Complicated methods of closure (Biondi, Brenner, Bier) are needed only in extensive herniæ of older children and do not essentially differ from operations on adults, to which reference may here be made (Wullstein).

The method described above is applicable to the youngest infant and can be carried out in a few minutes. The inhalation of a few drops of ether while opening the peritoneum is sufficient to prevent prolapse of the intestines; in older children local anæsthesia (novocain, 1 per cent.) is employed. The injury to the child is the least possible, the prognosis for the wound is more favorable on account of the few sutures employed, which are buried. The dressing is kept in place by a piece of adhesive plaster, which is applied over the sterile gauze covering the wound. To prevent the dressing getting wet or soiled, the child is placed on a frame which will be described in detail when dealing with inguinal hernia.

If necessary, this operation may be performed on out-patients, although I prefer to keep infants in the hospital until the clamps are removed on the fifth day.

The mortality is nil (in ninety-two cases), notwithstanding that many atrophic and poorly developed children were treated.

In small umbilical herniæ the closure may be effected by injection of paraffin (Escherich), unless the diameter of the umbilical ring exceeds $\frac{1}{2}$ cm. In such cases the method is dangerous, owing to the possibility of paraffin flowing into the abdominal cavity, and cannot therefore be recommended nor would the paraffin splint be able to retain more extensive herniæ.

In rare cases children may have a small hernia in the linea alba (Klausner). Generally, however, these are associated with a deformity in the umbilical region, and are likewise of congenital origin in so far that they are always associated with a congenital diastasis of the rectus muscles.

For their radical relief in children, it is sufficient to dissect out the hernial sac and to close with a purse-string suture any fascial gap that may be present.

3. INGUINAL HERNIA

Etiology and Origin.—The testes, or male genital glands, develop in pairs from the primitive structure of the Wolffian bodies behind the peritoneum on a level with the third lumbar vertebra (see Sketch of development). Cell masses soon begin to form, extending from this site to the later location of the testes outside of the inguinal canal, the testes gradually sinking into these cell masses in the course of growth. The cell masses indicate the path, as it were, which the testes have taken at various stages of growth in their fetal development. By the disap-

pearance of their proximal part, these cells, known as the gubernaculum Hunteri, rapidly disappear, leaving but the few remnants that are found later (Fig. 36).

In the region of the internal inguinal ring the peritoneum forms a cul-de-sac which is swept along by the testis and becomes deepened, forming the processus vaginalis. Apparently, therefore, the testis lies embedded in the invagination, or, perhaps, in one of its outer folds, although the walls of both are in close connection.

The migration through the inguinal canal commences in the sixth month and is completed at the time of birth, the left testis being already in the scrotum, while the right one usually occupies a higher position.

Accompanying the peritoneum, the other abdominal membranes and layers are swept along. The fascia transversalis will become the tunica vaginalis communis, and the muscle fibres of the obliquus internus will form the cremaster muscle in the scrotum. The continuation of the superficial abdominal fascia invests the structures of the scrotum as the dartos.

The peritoneal process is normally obliterated at the time of birth with the exception of its lowest part which permanently envelops the testis as tunica vaginalis. The obliteration occurs in various places at various periods, a fact which is of special importance for the topographical anatomy of the development of herniæ and hydrocele. (See Hydrocele, Fig. 38.)

If the process of development has taken a normal course, the peritoneum will pass smoothly over the internal inguinal ring; only a small groove, the fovea inguinalis lateralis, points to the process of development which has taken place.

Similar conditions prevail in the female. The ovary, however, remains permanently in the true pelvis. The gubernaculum testis persists as round ligament, while the existing processus vaginalis is soon closed (diverticulum; see Canalis Nuckii).

Thus, in every male fœtus we find normally in the seventh month an open processus vaginalis, a condition which persists in many species of mammals where the intestinal loops will not readily enter, even less easily than in the normal fœtus. The explanation is that the hernial rings are closed by muscles and that only a pathological change in the width of the rings or in the power of the sphincter, or a considerably increased internal pressure, will allow the intestines to pass through. The external inguinal opening in the normal newborn, whether slitlike or oval, will easily admit the little finger, while larger circular or triangular openings are of pathological significance. The muscular barrier is formed by the two oblique abdominal muscles, between which the inguinal canal is forced.
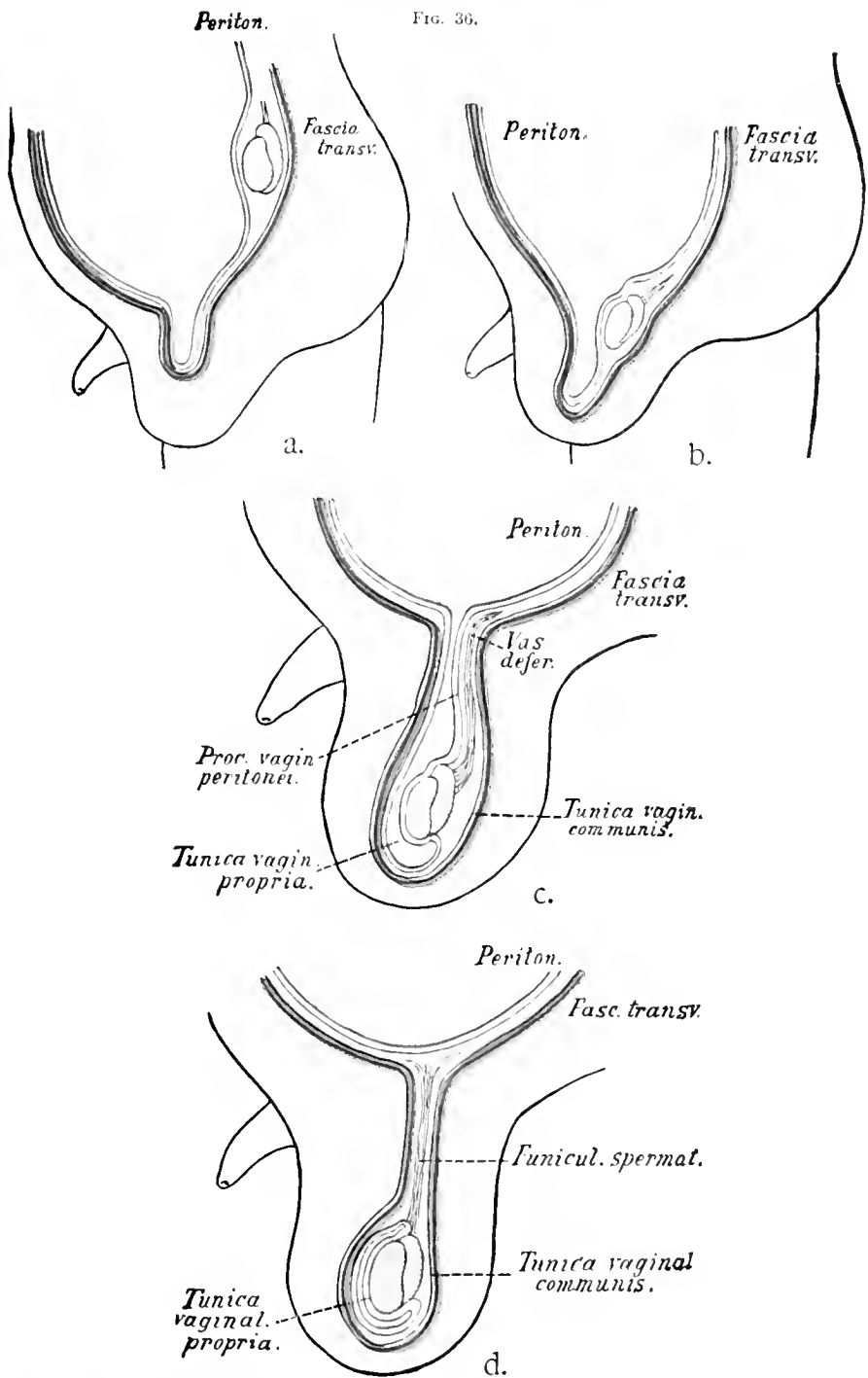
Descent of the testicle. *a*, position of testicle in about the fourth fetal month; *b*, position of testicle in about the sixth to seventh fetal months; *c*, position of testicle in about the ninth fetal month (development of the processus vaginalis peritonei); *d*, position of testicle at birth (development of the tunica vaginalis propria).

However, in about 50 per cent. of newborn infants the processus vaginalis is still open at the time of birth. This condition may change to normal during the first weeks, but it may persist for life often without causing any particular disturbance.

Pathological Anatomy.—If the intestines or other abdominal contents can pass into the preformed hernial sac, there exists an inguinal hernia which may be regarded as congenital. If the intestinal loop enters the open inguinal canal external to the plica epigastrica, it is called oblique inguinal hernia, as distinguished from direct inguinal hernia which may originate at a second weak portion of the abdominal wall, namely, the outer inguinal opening internal to the plica epigastrica.

In infants only congenital oblique inguinal herniæ are found.

I have never observed a case of direct inguinal hernia in children, perhaps because in children the inguinal canal runs straight and both openings, although wider, are situated nearly one above the other (Bühlmann).

If the processus vaginalis is completely patent it is called a complete hernia. It extends down into the scrotum, even if the testicle already lies there, for nearly all cases of incomplete descent are accompanied by complete hernia, as may be understood from the conditions of development (Fig. 36).

If the processus vaginalis is closed at its lower end and abdominal contents enter the open abdominal portion, it is an incomplete hernia. This may extend also into the scrotum, but even then the entire circumference of the testicle lies outside the hernial sac.

As in the case of other ducts lined with mucous membrane or endothelium, which when partially occluded may lead to cyst formation, cystic tumors may develop in the processus vaginalis, and these are called hydroceles. They may be combined with herniæ in many variations, and may remain in communication with the abdomen by a minute gap (hydrocele communicans).

It is very often found that in children the seminal cord, artery, veins, nerves, and vas deferens are not united in one cord, but are distributed along the circumference of the processus vaginalis in accordance with the disturbances of development they have undergone, and it is only after becoming detached in incomplete hernia that they unite as in the adult and, as a cord, proceed to the testicle.

Lateral prolapses between the layers of the inguinal canal occasionally occur in front of the peritoneum or between the muscles, producing the rare types of hernia—properitoneal, interstitial, or superficial.

Remembering the similarity of development in the female, we find there is a resemblance in the development of inguinal hernia. The canalis Nuckii represents the inguinal canal and the processus vaginalis

passes all the way along the round ligament into the labia majora. By following these details of development it is possible to explain easily the external pathological anatomy.

In the event of a complete hernia the testicle lies in its wall, protruding by half its size, as it also does in hydrocele of the testis. The seminal cord always runs at the outer wall of the hernial sac, but as the latter may be exceedingly thin it will sink into the epididymis.

As mentioned before, the testicles as well as the last part of the seminal cord are not connected with the hernial sac, although an exten-

Fig. 37a.

Complete bilateral inguinal hernia. Child fifteen months old. Hernia is congenital, and gradually grew larger. Inguinal rings round, admitting index finger. Herniæ have the size of a man's fist. Contents, intestinal loop; appendix palpable in the right scrotal sac; contents reducible. Penis completely drawn into the surface of the skin by the traction of the scrotal integument. Bilateral operation after Kocher. Right testicle difficult to detach from the hernial sac. The top of the hernial sac is left adherent to the testicle.

sive hernia may by its weight gravitate into the scrotum so that the base of the hernial sac may be contiguous to the testicle.

In both forms any kind of abdominal contents may be found within the sac, such as omentum, coils of small intestine, very often the cæcum and appendix; in females the ovaries (Figs. 37a and 37c). The intestinal coils and parts of the omentum which may be found in the hernial sac are generally reducible in herniæ which are not adherent to the sac and can be completely returned into the abdominal cavity.

The case is different if the cæcum with its broad surface, together with the parietal peritoneum, is dragged into the hernial sac. The appendix with its mesentery is adherent to the hernial wall, and, similarly, the cæcum may be adherent with its broad surface to the hernial wall, which at this place has of course originated from the parietal part of the peritoneum.

These conditions are, of course, subject to variations. For instance, anomalies are not rare in which the cæcum and the entire colon, hav-

Fig. 37b.　　　　　　　　　　　　　　Fig. 37c.

Fig. 37b.—Incomplete left inguinal hernia. Child three months old. Deformity existing since birth. Left inguinal ring 2 cm. in diameter, contents intestinal loop reducible. Hernia has the size of a fist. A triangular inguinal opening at the right. Operation on the left side after Kocher; on the right, canal suture.

Fig. 37c.—Bilateral inguinal hernia. Girl six months old. Bilateral inguinal rings enlarged, hernia extending into the labia. Contents on the left side, reducible intestinal loop; on the right side, intestinal coil and the irreducible ovary, which is well palpable as a spherical growth and painful. Operation after Kocher. After exposure of the inguinal ring the ovary becomes easily reducible. Cure.

ing a free mesentery, may, together with loops of the small intestine, find their way into the left hernial sac. In this case they are just as easily reducible as herniæ containing free coils and omentum. Otherwise difficulty in reducing right-sided hernia points with great probability to the cæcum and appendix as contents. (Personal observation of 16 cases.) (Fig. 37a.)

It has been mentioned before that in abnormal development of a descended ovary the latter may lodge in a hernial sac of the labia majora. This is not a rare occurrence in female infants.

It is intelligible from the anatomical conditions that the hernial

ring becomes considerably distended by the bulky contents and its frequent passage through the same. The fascial bundles, or pillars, continue to diverge. The sphincters become atrophied from want of use, while the cremaster is the only muscle that becomes hypertrophied; surrounding the hernial sac, it tries as a kind of self-help to prevent exaggerated distention of the hernial sac (Goldner, Bayer), thus forming a natural suspensory.

It occasionally happens not only that the serous coverings are tuberculous, but also that the inner wall of the hernial sac is studded with typical tubercles. (Observation of four cases.)

The **symptoms** of an incipient as well as of a developed reducible hernia are visible externally only as a rule.

A tumor of the inguinal canal, whether it lies in the canal itself, above it, or extends into the scrotum, arouses even in laymen the suspicion of hernia. If the contents can be pressed back into the abdomen, eliciting an audible intestinal gurgle, then the **diagnosis** is beyond doubt. In the absence of these symptoms, there can be confusion only with a bilocular hydrocele or one that communicates with the abdominal cavity. Translucency of the contents, palpation (elastic fluctuation), and percussion (air) will decide the question. A displaced testicle in the inguinal canal will be recognized by the fact of its absence in the normal place.

The differential diagnosis in irreducible hernia may present greater difficulties. But here, again, careful physical examination will prevent mistaking it for a unilocular hydrocele, without having to resort to a test puncture. When the hernia is tense, elastic and irreducible the condition is usually so serious that it can be recognized from the patient's general condition. Here we have to deal with a

STRANGULATED HERNIA

Intestinal coils are crowded into the hernial sac by the force of abdominal pressure; and if the hernial ring is narrow and the sphincter function relatively good, the hernial sac may easily become strangulated, thus preventing the return of the coils into the abdominal cavity. Accumulation of faeces, gas in the prolapsed loop, circulatory disturbances near the strangulating ring with consequent increase of the independent intestinal movements, aggravate the picture. The incarcerated loop is discolored and looks bluish red, the intestinal wall becomes permeable by its contents, the hernial fluid acquires an unpleasant sanguineous color, and unless the disturbing factor is removed there will be gangrene of the strangulated loop. Corresponding to these pathological changes, there are certain disturbances of the general and local conditions. The hernial tumor, which was at first reducible or at least soft, becomes hard

and tender. In many cases a painful tumor develops in a place where none had been noticed before. The abdominal wall of the affected side is tense and tender. Infants will draw up their legs, crying with pain, and the abdominal pressure is increased. This is accompanied by nausea and vomiting, presenting the picture of intestinal occlusion. Unless there is speedy aid, death will occur from shock, sepsis, or perforating peritonitis; only in rare cases (about 5 per cent.) a kind of self-cure has been observed by closure against the abdominal cavity and perforation of the strangulated intestine into the ichorous hernial sac.

I have not observed strangulation of the omentum in children. In adults the manifestations are less acute, and the intestinal movements are not materially interfered with, in spite of a bad general condition.

The opinion, frequently entertained, that strangulated hernia is rare in children I believe to be erroneous.

Nor are strangulations rare in older children with a slit-like hernial opening, especially in those where the hernia is associated with displacement of the testicle, although it should be admitted that a large portion of these herniæ are spontaneously reduced. Thus it may happen that a fair number of incarcerations in infants pass off untreated under the picture of violent colic.

The frequency of hernia also furnishes a measure for the degree of degeneration of the population, a fact which can be well verified in mountainous districts with their separate centres of population. In cities, industrial districts, and cretin valleys, hernia occurs frequently, while among the healthier mountain populations their frequency is much less. Their occurrence is disproportionately larger in boys than in girls, the proportion being 10 : 1, and this can be easily understood from the history of development.

The **prognosis** depends chiefly upon the treatment.

Many individuals go about with a congenital hernial tendency without knowing it and without ever contracting a hernia. In 200 autopsies, according to Murray, there were 68 cases with open processus vaginalis. Sudden exertion or great demand upon the abdominal musculature may cause the processus vaginalis to burst and allow the abdominal contents to enter. If the hernia has once prolapsed, there is little chance of a spontaneous cure, and this chance is lessened with each repetition of the prolapse. If there are abdominal contents present in the hernial sac, the only course for the sac is to become larger.

But whether a child has a true hernia or only a hernial predisposition, there is always the danger of strangulation, which is increased by various affections of the respiratory system (coughing), of the digestive tract (constipation, tenesmus), as well as by phimosis or physical effort.

Treatment.—Two different indications should be distinguished in the treatment.

a. *Treatment of Strangulated Hernia.*—As soon as the diagnosis is made and the duration of the affection established from the history of the case, the proper treatment should be instituted without delay. If the strangulation has not existed for more than 12 hours, manual reduction by taxis should be attempted. A warm bath, and especially ether anæsthesia, may materially facilitate the reduction by elimination of abdominal pressure (crying).

The following treatment has given me excellent results in children:

After a warm bath the child is slightly etherized, lifted by the legs to a vertical position and, by shaking the hernial sac, an attempt is made to replace its contents into the abdominal cavity. The traction of the mesentery will render considerable assistance in this position.

Strong manual pressure should be avoided, especially if the incarceration has existed for a long time. If the hernia proves irreducible by these light manœuvres, herniotomy should be at once performed. The hernial ring is exposed by an incision, the sac isolated in as high a position as possible, and opened at the top. (Microscopical examination of the hernial fluid.) The strangulated loop is pulled forward and it is often possible to reduce it without enlarging the hernial ring. Should this, however, prove impossible, the latter should be opened, which means enlarged layer by layer. After a careful inspection of the strangulated loop, the intestine is replaced if still viable, and the hernial ring is closed by some method of radical operation.

FIG. 37d.

Taxis in vertical position. The hernial contents are not yet entirely reduced.

The question whether the intestine is still reducible greatly taxes the experience of the operator.

Very young children, especially nurslings, bear an intestinal operation very badly, particularly if the general condition is weakened. On the other hand, the tissues of infants have considerable power of regeneration. The decision would, therefore, be in favor of reducing a danger-

ous looking loop rather than resorting to large resections, which nearly always have a fatal result. I have had to do so only once in thirty cases.

Should the hernia prove irreducible, resection should be done only in the absolutely healthy. Older children will bear the operation. Younger ones will not be spared the danger of resection by constructing an artificial anus, because, as the child becomes debilitated through the intestinal fistula, resection will in most cases have to be done to close the fistula.

b. *Treatment of Reducible Hernia.*—In order to avoid the danger of strangulation, the inguinal ring should be kept closed, which can be done either by constantly wearing a truss or by early radical operation. Opinions as to the selection of these methods do not agree. I am absolutely in favor of early operation, and in our clinic no trusses have been used since 1900. The disadvantages of the truss are:

1. If constantly worn, and not otherwise, it prevents the possibility of the bowels entering into the hernial sac. But one single hour at night, one paroxysm of coughing, may destroy the work of years.

2. It may cause the walls of the abdominal sac to become agglutinated while the hernial predisposition persists unabated. Not a single case is known where by wearing a truss real obliteration of the hernial sac has occurred, but many cases are known where, in spite of apparent cures, the hernia reappeared later.

3. The truss causes the sphincter musculature of the hernial ring to become atrophied through the pressure of a pad, thereby depriving the organism of a natural protection.

4. Physical education is prevented not only in children who wear a truss for existing hernia, but also in those in whom the hernial predisposition persists after discarding it. Improvement of physical vigor, increasing the power of resistance and facilitating the battle for existence, is rendered impossible by the continuance of the pathological tendency.

5. The only advantage of the truss is the possibility of deferring the radical operation beyond the first years of childhood without danger, but this involves a great deal of inconvenience, such as constant watchfulness, injury to the skin, eczema, etc., furthermore impairing the natural closure of the ring and consequent diminishing of the chances of a successful result of the later operation.

The only disadvantage of operation lies in its danger, and upon this depends the decision for or against early operation.

Only a large number of cases can give proper information on the question of danger.

Campel reports 305 operations with 3 per cent. mortality, Grossmann 111 with 1 per cent., Clogg 126 and Carmichael 152 cases with

1 death each, de Garmo 149 with no death. In my department 1100 cases were operated without a death that could be directly attributed to the operation. (See Mortality, p. 88, and also compare Cooley and Bühlmann.)

The majority of the reported deaths are due to complications, many of which are attributable to disturbances occasioned by prolonged anæsthesia. If it is possible to simplify the operation to such an extent that, without detracting from its efficiency, it can be carried out under very short anæsthesia, then this slight surgical interference, which does not require more than a few minutes, must be considered devoid of danger and vastly superior to the wearing of trusses.

Kocher's method of invagination in children has shown better and more brilliant results than any of the other methods at present in use. All authors admit that in infantile herniæ, which are generally reducible, the simplest methods of closure are the best, in view of the existing tendency of nature to effect a cure. The pillar suture of Wölfler and ordinary ligation and burying of the hernial sac are sufficient in many cases (Nötzel). But in order safely to prevent relapses, only the methods of Bassini and Kocher can be considered. Space prevents mentioning the innumerable modifications of these methods. All the later methods of closure are based on one of these two, and variations are only needed to suit the skill of the operator and the diversity of the cases.

Bassini's Method.—Skin incision along the entire inguinal canal, exposure of the outer hernial ring, cleavage of the aponeurosis of the obliquus externus extending to the internal inguinal ring, exposure of the hernial neck at the internal pillars, isolation of the sac after dissection of the tunica vaginalis communis. In isolating the hernial sac, difficulties may easily be encountered in children, chiefly owing to the fibrinous nature of the structures of the seminal cord.

The easiest way to effect the separation is the blunt method with the aid of cotton tips. Forceps may easily tear the hernial sac, as it is often very thin. The vicinity of the inguinal ring is the best locality to begin the separation, proceeding distally from this point. If the tip of the hernial sac is difficult to separate, as in complete congenital hernia, the hernial sac should be opened and its contents reduced, leaving the remnants of the sac in the scrotum. After reduction of the contents, the hernial sac is ligated or closed with a purse-string suture. The muscular mass of internal oblique and transversalis is sutured to Poupart's ligament behind the seminal cord and the aponeurosis closed over the cord. In this way the termination of the seminal cord is placed upon the inner inguinal ring and the oblique direction of the muscular inguinal canal is corrected. This serves to give the inguinal canal a firm posterior wall.

Kocher's Displacement Method.—The hernia is exposed, the sac is isolated, the aponeurosis remains uncleft, the hernial contents are

reduced, and the free hernial sac is passed through a small opening laterally from the inner inguinal ring, where it is ligated and sutured into the opening. In this way it is laterally displaced.

In Kocher's *invagination method* the isolated and unopened hernial sac is caught at the top with a slightly curved crenated forceps, inverted into itself, the point of the crenated forceps pushes the inverted top through both the outer and inner inguinal rings into the peritoneal space, passes along of them for about 2 cm. beyond the inner inguinal ring, until it pushes with its beak against the anterior abdominal wall. The fascia with the layers underneath, including the peritoneum, are opened over the protruding head of the crenated forceps, and the inner wall of the anteverted hernial sac is pushed forward through the small opening. It is caught by forceps and vigorously pulled forward, two other artery clamps engage the lips of the peritoneal incision, in close proximity to which the hernial sac is perforated and ligated, and with the same thread the peritoneal and abdominal wounds are united. The wide inguinal canal, which now contains nothing but the structures of the seminal cord, is narrowed, if necessary, by interrupted sutures (canal suture).

It will be seen from a comparison of both methods that the invagination method can be carried out without difficulty in children, their herniæ being generally free and small. The inguinal ring is not so large as in adults, where a muscular closure is necessary at the posterior surface of the inguinal canal. Besides, in infants there is but an aperture, and seldom a canal, so that narrowing the hernial ring is sufficient to reduce its size. Muscular suturing is beset with great difficulties in infants, there being usually only fibrous bundles which easily tear. If these are gathered up transversely to obtain a better hold, they would of course become necrotic between the sutures when tying them to Poupart's ligament, and the object of the operation would be frustrated.

In Kocher's method the aponeurosis is not cleft. Lodging the seminal cord out of its natural bed is not devoid of disadvantage, later investigations of the results having in many cases shown an elevated position of the testicle on the side operated upon after Bassini's method. It should also be considered that this method requires a much larger quantity of buried suture material, which always impairs the chances of cure, however perfect the asepsis. The great liability to infection in this region, together with the persistent friction of the abdominal walls against each other, although not actually productive of traumatic disturbances, may easily lead to breaking of the sutures.

Its application according to the following steps can be warmly recommended:

1. The incision is made as high as possible, going upward from the inguinal ring, in order to keep away from the region of the abdominal openings.

2. The skin incision having been continued to the fascia, the index finger of the right hand inverts the scrotum with the hernial sac, pushing the latter forward to the skin incision, so as to bring it into view.

3. The neck of the hernial sac is caught, freed all around with a blunt instrument, and placed in front of the skin incision.

4. The tunica vaginalis communis is dissected and the neck of the hernial sac isolated with a blunt instrument. This should be done as rapidly as possible, as otherwise the tender structures are apt to become dry, which renders the separation exceedingly difficult. The isolated fibrous structures of the cord are caught with a ring forceps, collected and dissected off distally from the hernial sac. Should there be difficulty in dis-

FIG. 37e.

Bilateral hernia on the second day after operation (Kocher); iron frame, leg bands, and corset.

secting it, the contents are replaced, the hernial sac is cut through, and the tip is left in connection with the other parts. The central stump is ligated.

5. Next, the isolated sac or its ligated stump is invaginated according to the method of Kocher. The beak of the invaginating forceps is passed carefully upward along the peritoneal wall so as to avoid engaging an intestinal loop. The invaginated hernial sac is drawn through the peritoneal wound, perforated and ligated, the superfluous flap dissected off, the central stump buried, the peritoneum and fascia being closed with the same suture. In this way the peritoneum is drawn upward from the funnel toward the inguinal ring.

6. An assistant catches hold of the testicle in the scrotum, drawing it downward. This serves to tighten the seminal cord in the inguinal ring and to allow an inspection of the lumen of the canal. Should this be too wide, two interrupted sutures will be sufficient to narrow it.

7. The skin is closed with metal clamps, silk sutures being apt to carry infectious material into the wound. The wound is painted with tincture of iodine and a resinous solution, and covered with a small plaster bandage. The larger the bandage, the greater is the difficulty to keep it clean.

8. The child is placed on a frame (Fig. 37c), which is so constructed that it fixes the chest, back, and legs, but leaves the abdominal openings free. The frame is slung up in the cot so that a small pan can be placed underneath to receive the stools and urine.

9. The child remains on this frame until the fifth day, when the skin clamps are removed and the bandage renewed with a perforated small plaster to drain the wound dry. When there is no further danger of infection, the child can be removed from the apparatus and sent home. Older children are able to leave the bed on the eighth day.

The frame is, of course, intended for infants who can not yet control their excretions. It does away with all trouble of bandaging and answers all requirements of hospital practice in keeping the wound clean. Children may be carried about on the frame without danger, which constitutes a great advantage in case there is danger of pneumonia.

The time required for operation according to this method is very short, four minutes being sufficient under favorable conditions, while eight minutes are sufficient for difficult dissections and extensive herniæ. A few drops of ether are sufficient for anæsthesia. Nurslings are not anæsthetized at all, in order to avoid the digestive disturbances, which are frequently serious. The operation is so insignificant that even weak and atrophic children may be subjected to it. It is just this class of children that do not bear skin bandages well, while the rapid growth of the hernia urgently demands interference owing to muscular insufficiency in function.

It will be understood from this description that Bassini's operation should be thought of in infants only when the hernial contents are broadly adherent to the hernial sac (cæcal hernia) and in those forms of incarcerated hernia in which it is necessary to incise the sac up to the ring. I give the preference to Bassini's plastic method also in very large herniæ with a very wide hernial ring in the case of older children.

The mortality is exceedingly small. Of 1100 operated cases, including 20 per cent. infants, we lost only four; two of these succumbed to epidemics (house infection) that happened to prevail, one to pneumonia two days after operation and one eight hours after operation to status thymicus, established at autopsy. Thus only the last two cases are directly attributable to the operation, and they refer to infants at a time when we still anæsthetized them. This was one of the reasons that caused us to discard anæsthesia, even ether slumber, in hernia operations on infants.

Operation for inguinal hernia on a female child does not materially differ from that on a male child. Absence of the seminal cord facilitates the closure of the inguinal ring, but aggravates the search for the inguinal sac, especially in a small hernia and where there is abundant adipose tissue, since they may be confused with lipoma (see Tumors). Should the ovaries be prolapsed, they should of course always be replaced in position. The round ligament should be spared, if possible.

A truss should not be worn after operation, as it would only have an injurious effect upon the muscular closure. Older children should refrain from physical exercise for six months after operation, or at least from such exercise as would increase the abdominal pressure from relaxation of the anterior abdominal muscles (as in swimming). Otherwise the children may be considered normal.

Trusses and similar bandages should now only have historical value, except in cases where the somatic condition of the patient renders an operation absolutely impossible. If, however, a truss is worn at all, it should be done without in-

FIG. 37f.

FIG. 37g.

FIG. 37f —Skein truss ready for use.
FIG. 37g —Skein truss showing linen bands being drawn through loop (a).
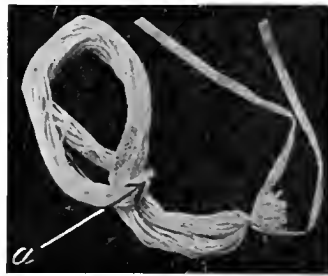
terruption, as a single unguarded cough may loosen the agglutinations of many months. In younger children a bilateral truss should be applied from the first, as it is less easily displaced and affords protection to both inguinal canals, the predisposition to hernia being usually bilateral. In infants the truss should be changed and dried more frequently, and the material from which it is made should therefore be selected accordingly.

Fiedler suggested wool trusses, which can be recommended owing to their cheapness and easy arrangement. The following is his description of the same taken from the *Centralblatt für Chirurgie*, 1906:

"The improvised truss consists of a skein of white wool of about 20–30 threads. This is made into a loop 35–45 cm. in length according to the size of the little patient. Two narrow white linen apron-strings are attached to one end of the loop. Zephyr wool, ready in skeins of about the required length, is for sale in the stores.

Fig. 37f shows the loop ready for use. The hernia being reduced, the loop is placed around the abdomen like a belt. The end carrying the linen bands is drawn through the loop, as shown in Fig. 37g. A small, firm ball of clean cotton wool is placed in the inguinal region, the cross point of the loop to rest upon the same. The end of the loop is drawn tight around the thigh and the linen bands are tied to the belt.

The elastic pressure of the wool skein, tightly drawn over the ball of cotton wool, is quite sufficient to prevent the prolapse of the hernia. Instructions are given to have half a dozen of these wool loops in readiness, so that a clean one may be applied each time the child is changed. The child may be bathed without removing the bandage.

For bilateral hernia two loops should, of course, be applied.

The arrangement is cleanly, simple, inexpensive, and thoroughly reliable.

4. FEMORAL HERNIA AND THE OTHER RARER FORMS OF HERNIA

(See Langstein, vol. iv.)

Femoral hernia is a very rare occurrence in children, only one case in an older girl having occurred among 1100 cases I have operated upon. The operation is exactly the same as in adults, and the surgical text-books should be consulted for particulars.

The other rare forms of hernia are not of any special importance in the surgery in childhood.

Congenital hernia of the diaphragm is usually associated with other gross deformities and is of no surgical interest in childhood.

5. HYDROCELE

Origin and Pathological Anatomy. — As cysts may form where portions of embryonal ducts persist, so they may also develop owing to incomplete obliteration of the processus vaginalis along the entire route which the descending testicle traverses. There are several kinds according to their persistence and locality, although there is no material difference between them.

In many cases the entire processus vaginalis remains and its peripheral part becomes distended through secretion of a serous fluid. Communication with the peritoneal cavity is often very narrow and may become entirely occluded in isolated cases. If the pedicle remains open, there may be the picture of a changing hydrocele which becomes filled

with serous fluid during the day when children run about, while during the night it may become evacuated; it may entirely disappear for a time and then reappear, lasting for a longer time. (Communicating hydrocele; see Inguinal hernia.)

The processus vaginalis may also assume an hour-glass shape, so that one of the ampullæ lies within the inguinal ring and the other without, perhaps in the scrotum. As they communicate with each other, they may alternately be filled or emptied. (Bilocular hydrocele.)

Fig. 38.
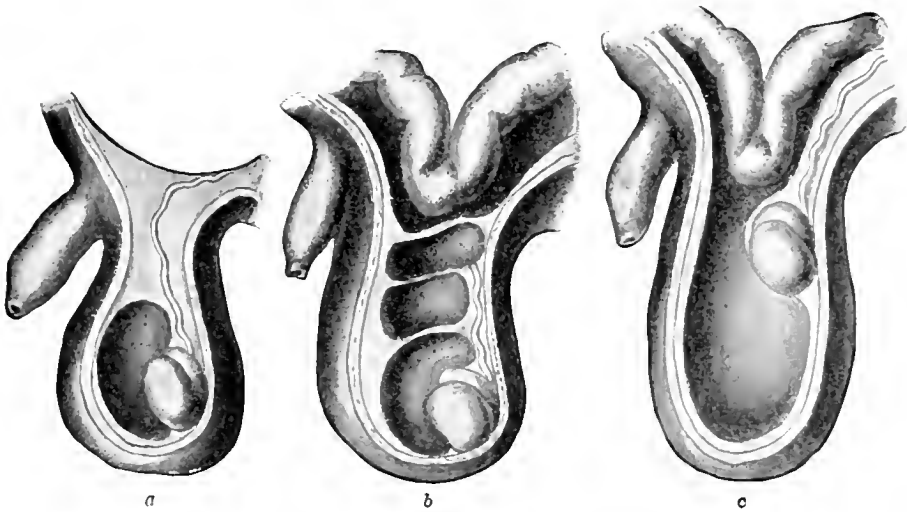
a, ordinary picture of hydrocele testis. The tunica vaginalis propria is distended by an accumulation of fluid, the parietal peritoneum passing smoothly over it. b, hydrocele testis, hydrocele funiculi spermatici, and inguinal hernia. The processus vaginalis periton. is adherent at various places, producing several superposed sac formations; hydrocele of the testis at the fundus of the scrotum; above, two hydroceles of the seminal cord; at the top, the hernial sac. c, communicating hydrocele, secondary inguinal hernia. Owing to incomplete descent of the testicle, the processus vaginalis periton. has failed to become obliterated, forming a communicating hydrocele with secondary development of a hernial sac through prolapse of an intestinal loop. This condition is also called hernial hydrocele.

That part of the processus vaginalis which normally persists as the tunica vaginalis testis, develops most frequently into a cyst. (Hydrocele testis.)

Cysts may also develop in the shape of a rosary along the entire length of the seminal cord, a reminder of the embryological fact that the processus vaginalis does not undergo uniform and simultaneous involution. If a large portion of the cord persists as a cyst, there will be found a finger-shaped tumor accompanying the seminal cord and this is called hydrocele of the cord. (Hydrocele funiculi.) (Fig. 38.)

It is in the nature of these processes of development that with a widely open abdominal aperture of the processus vaginalis hernia may be associated with any form of hydrocele, a combination which is very frequently observed in hernia operations.

The etiology of this excessive accumulation of fluid in the remaining parts of the processus vaginalis is not yet completely clear. The theory that the source of the fluid is the peritoneum can only apply to cases where there is communication with the peritoneal cavity. For the other cases it is necessary to assume a hypersecretion of the serous membrane, such as also occurs in other similar organs, as for instance in the membranous sheath of the scrotum when traumatic and inflammatory processes cause a collection of fluid. (Difficult micturition, phimosis.)

The inner membrane of the hydrocele has the histological character of the peritoneal covering (Foederl). If the hydrocele has existed for a long time, especially with intercurrent traumatic and inflammatory changes, traces of these are present in the shape of cicatricial thickening. The testicle is usually situated slightly above at the posterior wall, while in large hydroceles the typical position is obliterated.

Fig. 39.

Right hydrocele of the testis and seminal cord. Child three years old. The right scrotal half is tense and elastic, transparent, contents fluctuating, irreducible; empty percussion sound, inguinal ring small, slit-shaped. Bottle operation, cure without relapse.

Symptoms.—The first symptom is an increasing swelling in one-half of the scrotum. The other manifestations will, of course, depend upon the kind of hydrocele, as described above. The swelling is usually smooth and tense. When the tension is considerable, it is usually difficult to detect any fluctuation. There are often annular constrictions at the places which correspond to the obliterations of the processus vaginalis. The tumor is transparent, displaying a reddish-yellow tint, which can be observed when looking through the tube of a monaural stethoscope.

Hydrocele cysts may occur also in the female along the round ligament, corresponding to the canalis Nuckii.

Diagnosis.—The presence of an irreducible hernia forms the only diagnostic difficulty.

If the tumor is reducible, it can only be a hernia, except where there is a bilocular or communicating hydrocele, but in these cases the contents, consisting of intestinal coils or free fluid, can be easily made out owing to the slight tension.

In the presence of a tense, hard, irreducible tumor, which the history has shown to have existed for a long time without impairing the general condition of health, a diagnosis of hydrocele should be made. The only

real difficulty might occur in a female child, where such a tumor might either be a hydrocele or a prolapsed ovary, but the painfulness of the latter on pressure will facilitate the diagnosis.

I am unable to approve of test punctures of the tumor. At least they impair diagnostic precision which can be attained by the aid of all the existing symptoms. It will not be difficult to recognize complications by hernia, if all symptoms are carefully sought for and considered.

Prognosis.—The course is characterized, as in other cysts, by slow but steady growth. In young children, especially where there is a communication with the peritoneal cavity, the communicating passages may undergo spontaneous obliteration. This may also occur if, in the presence of phimosis, constipation, etc., the abdominal pressure is reduced by removing the causative factors.

Treatment.—Inunction with iodine ointment has been recommended for the purpose of accelerating absorption, but I have never been convinced of its practical utility. The simplest remedy is puncture, which is carried out in the following manner:

The tumor having been disinfected, it is punctured at the dome and the fluid evacuated. Care should be taken to avoid the testis and epididymis.

We have discarded injections of tincture of iodine, alcohol, adrenalin, etc., because they frequently lead to severe exudations, causing unnecessary complications.

In all manipulations of the scrotum of the newborn, it should be remembered that the skin is very tender and not well nourished. In a case where kelene (ethyl chloride) was applied to the skin, I saw cutaneous gangrene occur over the entire area where the anæsthetic was employed.

The usual treatment instituted in our clinic is as follows:

Small hydroceles of the testes in nurslings are left untreated; factors causing increased abdominal pressure, such as difficult micturition and phimosis, are removed.

Larger hydroceles which are closed off from the peritoneal cavity are punctured without making any subsequent injections. If there is a relapse after two punctures have been made, the radical operation is resorted to. In communicating hernia the processus vaginalis is immediately closed. (See operation for Hernia.)

The radical operation for hydrocele consists in the extirpation of the tumor, the necessary precautions being observed as described for hernial operations.

Incision into the scrotum should be avoided, owing to the danger of infection. The incision should be made as high as possible, because the tumor can be removed through a high incision by the manipulation

described in hernial operations. Besides, such an incision can also be used for the closure of an open inguinal canal or for the radical operation of an accompanying hernia.

The preferable method is enucleation of the tumor as a whole, if such be possible. Attention should be paid to the pedicle, which should be ligated if, as is often the case, it is adherent to the inguinal canal. Should the tumor burst during the manipulation, it will often be difficult to dissect the tender serosa from the other structures, and in that case Winkelmann's operation is indicated. The hydrocele sac is incised, avoiding all visible vessels, and everted so that the inner serous membrane will have an outward aspect. In this position it is fixed by a few sutures, and the testicle, which is now situated at the outer surface, is replaced, together with the structures to which it adheres. This should be done in such a way that the serous surfaces will not face each other, as this may cause a relapse through the formation of a serous sac.

Andrews's "bottle operation" is intended to prevent such a contingency. A small incision is made at the neck of the tumor, through which the testicle, together with the inner membrane, is everted. No suture whatever is necessary after this operation, owing to the smallness of the incision. The results are very good, and there has never been a relapse in my experience.

The "Raff method," devised by Klapp to prevent relapses, consists in the following proceeding: The sac having been incised, a few silk threads are drawn through its inner membrane, which is collected into a bundle by tightening the threads. The tissue structures are said to become absorbed within a year. This method has certainly great advantages in operations on adults, while in children I prefer the method above described, avoiding buried sutures as far as possible

ADDENDA TO SECTION IV

1. Anomalous Position of the Testicle

(Retention and ectopia of the testicle. See Langstein, vol. iv.)

Differentiation and Etiology.—Retention of the testicle occurs if the latter is arrested at any part of its way from the lumbar vertebræ to the scrotum, and remains in that position after birth. [Undescended testicle.]

If later in life this position, as occasioned by the embryological development, is changed either by gravity or other physical laws, causing the testicle to find its way into other cavities, or by its being displaced in another direction from pathological causes (crural canal), we have a condition called ectopia of the testicle.

Retention occurs in various forms, according to whether the testicle is retained in the abdominal cavity (cryptorchism) or in the inguinal

canal. Ectopia includes abnormal displacement in the crural canal or in the perineal tissue (ectopia cruralis or perinealis).

The causes are probably always disturbances of development on a biological basis, as previously described. All other explanations, such as inflammatory processes and occlusions, are hypothetical.

The **symptoms** manifest themselves externally by absence of the testicles from the scrotum.

Fig. 40.
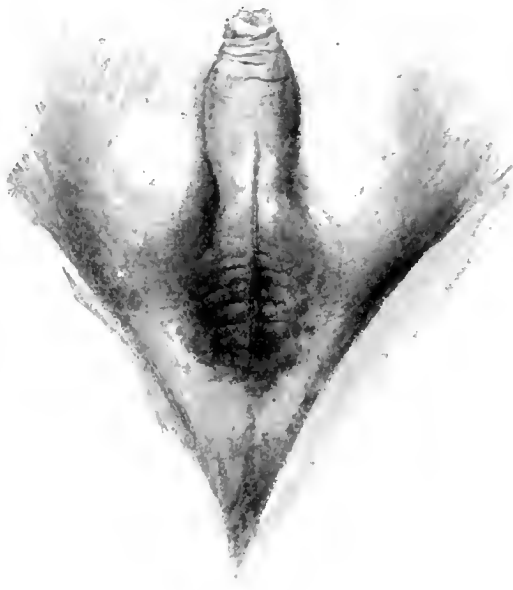
Inguinal retention of the testicle, bilateral hernia. Child three years old. Scrotum empty and very small. At both sides of the inguinal ring two tumors are visible containing intestinal loop and the testicles. They are reducible together with the testicles. Operation by the "fan" method. The testicles can be drawn down almost into the scrotum.

It has often been observed that in a large number of newborn the inguinal canal remains permeable for the testes for a considerable time. Under the influence of cold or of the cremaster reflex (stroking the inner surface of the thigh) the testicle, being situated in the inguinal canal, may retract into the abdominal cavity and reappear as soon as the external stimulus ceases.

A pathognomonic sign in all these children is an unusual smallness of the scrotum, but this is probably secondary and not an etiological manifestation. In all these children, too, the processus vaginalis is open. In many cases I was able to arrive at this conclusion from the palpable thickness of the seminal cord; in others proof was furnished later by the development of a hernia. The position of the testicle can always be established by careful examination of the inguinal canal and its vicinity, the painfulness of the little tumor serving as a sure guide.

Subjective symptoms will only manifest themselves in the event of incarcerations in the muscular apparatus of the inguinal canal which may lead to severe symptoms, such as vomiting, nausea, or pains in the inguinal region (pseudo-appendicitis).

Prognosis.—Attention to the conditions arising from the history of development as well as observation of a large number of such cases has demonstrated that the testicle, as it increases in weight, may in the further course of development spontaneously find its physiological position. Should it remain at its abnormal place owing to shortness of the accompanying tissues, its further growth seems to be interfered with; but in unilateral arrest of descent compensation nearly always occurs by increased growth of the other testicle. Frequent irritations and incarcerations are no doubt a fruitful source of pathological new growths in the region of the retained or ectopic testicle.

Treatment.—This anomaly should be corrected if it causes subjective complaints. No treatment is necessary if the testicle lies either completely in the abdominal cavity or above the inguinal canal, so that none but inguinal testicles demand interference. Attempts have been made to effect an elongation of the seminal cord by bifurcated pads and massage manipulations and in this way to cause a normal localization of the testicle (Sebillau and Goltmann). But mechanical irritation of this kind should, of course, be discarded in the treatment of children.

Wearing a truss to prevent prolapse into the inguinal canal reduces the patient to the condition of a cripple without absolutely preventing occasional incarceration. These considerations lead to two principles of treatment, viz.:

1. Ectopia causing no visible complaints should be left untreated.

2. In the event of pain or of a visible hernia radical operation is indicated.

In all cases of inguinal testicle we have operated upon, there was also a congenital hernial sac, which can be explained by the history of development. The hernial sac was isolated, incised in the middle, the upper part cared for after Kocher's method, and the lower part adherent to the testicle was used to anchor the testicle by the fan method to the

bottom of the scrotum or at the septum, or at least as far down as the shortness of the cord structures would permit without causing undue tension.

I prefer this method to all others, because the tissue of the testicle remains untouched and its motility is not greatly disturbed. The outer inguinal ring should be sufficiently narrowed to prevent the testicle from sliding back.

Suturing the testicle itself should only be considered in the absence of an available hernial sac (Orchidopexy, after Kocher, Nicoladoni, Lotheisen, Broca). Mauclair's method to suture the ectopic testicle to the healthy one, or to suture both ectopic testicles together, is in my opinion not physiological.

A testicle which cannot be moved to a position in front of the inguinal canal is best placed in the abdominal cavity and the inguinal canal closed.

Castration in children is certainly inadmissible.

2. Congenital Deformities of the Female Genital Organs

Aside from the deformities already described, viz., communication of the genital tract with bladder and rectum, hypospadias and epispadias, complications and herniæ (ovaries and uterus as hernial contents) along the canalis Nuckii, with hydroceles in the latter region, there are occasionally other deformities of the female genitalia which may be mentioned. Gross uterine deformities, such as bicornis and atresia, will be omitted, as they do not manifest themselves before puberty and are dealt with in the gynæcological text-books (Hæmato-colpos, hæmatometra).

The earliest deformities that claim the pediatrist's attention are more or less light occlusions in the region of the vulva.

The labia majora, and sometimes also the labia minora, may be occluded to such an extent as to interfere with micturition or to lead to accumulation of stagnant mucus and to the formation of cystoid structures which protrude from the vulva. Separation can easily be effected with a blunt instrument, scissors being but rarely required.

Careful inspection guards against mistaking this condition for an imperforate hymen which can only lead to complaints at the beginning of menstruation (hæmatocolpos).

Ovarian cysts, however, occur in young children, and their extirpation according to general rules offers no difficulty.

As to other abdominal tumors and their differential diagnosis, gynæcological text-books should be consulted.

E. CONGENITAL DEFORMITIES OF THE EXTREMITIES

According to Geoffroy Saint-Hilaire the following classes should be made of deformities of the four extremities having the same pathogenesis and etiology:

1. Ectromelia, where one or more of the extremities are entirely missing.

2. Hemimelia, where only the proximal part of an extremity is developed, the organ becoming more rudimentary as it proceeds toward the periphery.

FIG. 41.

Amniotic amputation of the left forearm. Child three years old. Instead of the left forearm there is a stump which is movable in the rudimentary elbow-joint where the biceps and triceps muscles are inserted. Polydactylism of the right foot.

3. Phocomelia, where the upper segments are missing, the distal segments—hand or foot—protruding direct from the body.

The pathogenesis of these deformities, as well as of partial defects of the various extremities, is explained by the failure of the extremities or their parts to connect.

The etiology consists in a disturbance in the course of development, caused either by degeneration or accidental strangulation and adhesions

owing to interference by bands and folds. The latter may be normally present in the neighborhood of the embryo, or they may have developed through pathological processes (strangulation by the umbilical cord amniotic bands). Deep constrictions are sometimes present after birth as evidence of such strangulations which, by growing deeper into the tissues, may lead to congenital amputation (Figs. 41 and 42). Piéchaud has published illustrations of phocomelia in brother and sister.

Both the biological and traumatic etiological factors may occur combined, as the solitary or continuous effect of a trauma may give a pathological direction to the course of development. Fig. 41, for in-

FIG. 42.

Traumatic manus vara, caused by strangulation of the umbilical cord. The scar lines which are still visible have occurred at decubital places which had caused the firm twist of the umbilical cord.

stance, illustrates a combination of strangulation and polydactylism. Fig. 42 shows manus vara caused by the twisting of the umbilical cord. In this way it is possible to explain easily on a biologico-degenerative basis the occurrence of amputations and other deformities of the extremities.

I. CONGENITAL DEFORMITIES OF THE UPPER EXTREMITIES

CONGENITAL ELEVATION OF THE SCAPULA

This deformity was first described by McBurney and Sands and was communicated to the German literature by Sprengel in 1891.

The scapula is displaced upward and apparently turned around a sagittal axis. The deformity, which occurs less frequently on both sides, is attributed to secondary causes manifesting themselves as changed functional requirements from uneven traction of the inserting muscles.

The mesial upper angle is curved upward and away from the verte-bral column, protruding like an exostosis from under the shortened

trapezius. The head is generally inclined toward the affected side under the influence of considerable cervical scoliosis which corresponds to a compensatory thoracic curvature of the vertebral column.

These changes in the position of the head and vertebral column, which must be regarded as of secondary origin, vary in different cases, except that nearly always the arm cannot be raised above the horizontal line, pointing to the disturbed balance of the muscles which control the shoulder girdle.

The pathogenesis of this deformity is still unknown, but in all probability inhibition of development is again responsible. The scapula, which in the embryonal period was attached to the vertebral column in an elevated position, may have been arrested in its descent and, in the course of later development, may have undergone descent and torsion, as is still recognizable from the spiral structure of the brachial plexus (Holl).

This explanation is confirmed by the fact that this deformity is frequently accompanied by other malformations the etiology of which is better recognized. A woman with an abnormal pelvis, after a labor lasting seventy-two hours, gave birth to a child with bilateral talipes and elevation of the right shoulder. (Personal case.) Putti described a case of syphilis with congenital elevation of the shoulder-blade, in which the latter remained connected with the first thoracic vertebra by an osseous bridge as a result of syphilitic intoxication of the germinal layer.

The **treatment** is principally directed against the occurrence of secondary manifestations, such as torticollis and scoliosis. The bloodless and mechanical treatments do not practically influence the deformity. There is greater hope for improvement in resection of the mesial upper scapular angle and plastic elongation of the shortened muscles (resection, after Sands), X-ray pictures being able to direct the operative measures reliably.

Congenital luxation of the humerus in the shoulder-joint is an occurrence of great rarity. It is probable that these luxations have occurred during birth, as they are often associated with injuries to the regional nerve trunks.

Treatment.—Reposition of the dislocated part should be attempted, failing which operative treatment should be resorted to, taking the most prominent symptoms into special consideration (Hoffa, Kirmisson).

Deformities of the arm bones are very rare. In most cases they belong to one of the three groups which have been described in the beginning of this section.

Congenital luxation occasionally occurs at the olecranon, consisting principally of isolated luxation of the radius anteriorly. In this deform-

ity, too, there is usually an osseous bridge between radius and ulna, which distinctly points to an arrest of development. The radius stands in pronation as in quadrupeds, while the later supination has failed to occur. (Quadruped position; see Scapula.)

Symptomatically this deformity naturally produces disturbed function of the elbow, the hand being permanently in pronation and unable to assume supination, while the forearm cannot be completely flexed at the elbow-joint.

The treatment consists in the removal of the impediments to motion. Resection of the head of the radius will effect an improvement, unless

Fig. 43.
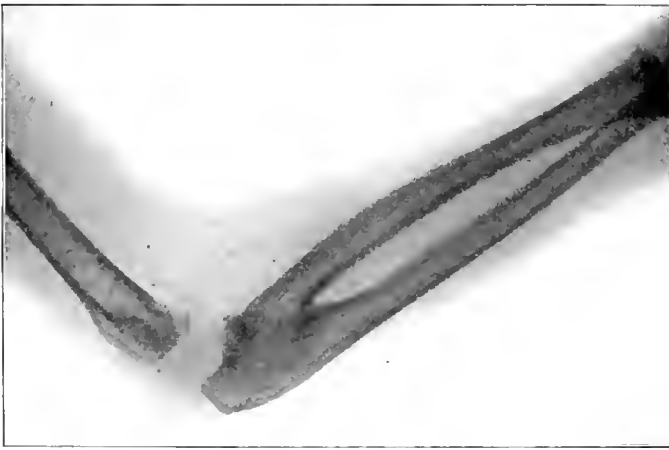
Luxation of the radius anteriorly. Synostosis of both bones at the proximal and distal ends in child six years old.

there are also bony bridges between both forearm bones at their distal ends. An X-ray picture will furnish the necessary information on the subject.

Kölliker observed in a few cases abnormal growth of the radius when resected out of its natural position.

Congenital ankylosis of the elbow-joint and complete or partial defects of the forearm bones constitute arrests of development which are rather rare. These deformities are usually associated with club-hand (manus vara). This deviation of the hand, forming an angle with the forearm, has been called club-hand by general consent, and this of course includes fixation in this position. It signifies the rest position which must be assumed before certain restricted movements can be executed. The most frequent fixation is in palmar and ulnar flexion. Any of the other forms occur less frequently.

Club-hand without simultaneous malformation of the forearm is a very rare deformity, its occurrence in conjunction with missing radius

or ulna being more frequent. The radius is absent more frequently than the ulna, and in this deformity the hand is radially deflected as if broken off, standing at a right angle to the ulna. Its termination is easily palpable under the skin. The thumb and its metacarpus, in fact the entire radius, are likewise missing.

The ulna is less often absent, a more frequent combination being club-hand with ankylosis of the elbow-joint.

Stoffel's investigations have shed more light on the pathogenesis of this deformity. In his opinion there has been a pathological course in the process of development, caused by increased uterine pressure, or an atavistic deviation, as indeed appears probable from the frequent coincidence with other deformities, strangulations and occlusions, pointing to the same causative factor.

Fig. 42 illustrates a club-hand caused by twisting the umbilical cord around the forearm, the child having been brought to the clinic with the visible pressure necrosis of the forearm.

In these latter cases the treatment is facilitated, because these positional changes which occur at a much later period are, as it were, of secondary origin and may be corrected by adequate orthopædic treatment with felt-covered steel springs, elastic traction or splints (Lange's orthopædic glove). In germinal errors, which occur at a much earlier period, the entire motor apparatus is involved, and the mechanical as well as the operative treatment is much more complicated, having to reckon with the small size and tender infantile tissues and the very susceptible infantile skin.

Bardenheuer has achieved good results in cases of absent radius by cleaving the ulna and inserting the carpus into the bifurcation. The style of the operation—elongation or shortening of the tendons, etc.— would of course vary with the pathological picture.

The fact of accompanying ankylosis of the elbow-joint points to very early inhibition of development; and if mechanical correction is impossible, linear resection is indicated, the shortened triceps tendon being plastically elongated.

Congenital Deformities of the Fingers.—The pictures resulting from structural disturbances of the end radiations of the extremities may vary exceedingly. Incomplete development or diminished numbers (oligodactylism), atavistic retrogression to supernumerary radiations (polydactylism), absence of separation, presence of adhesions (syndactylism), secondary fissures, etc., may give rise to the most varied pictures. The biological factor is common to all that they owe their origin to an abnormal course of development, in which heredity plays an important part.

Polydactylism gives the most frequent occasion for surgical interference, not only for the reason that parents dislike having "marked"

FIG. 44a.

Manus vara with radius defect on the right. Pollex duplex on the left. Ankylosis of the right elbow. First metatarsal bone and great toe of right foot absent. Child seven days old Operation after Bardenheuer.

FIG. 44b.   FIG. 44c.

FIG. 44b.—X-ray picture of the bone of the right arm.
FIG. 44c.—X-ray picture of the bone of the left arm. The supernumerary radial thumb grows obliquely from the metacarpus and is incapable of function.

children of this description, but also because the supernumerary fingers are but rarely capable of useful function.

It stands to reason that all the rules of cosmetics should be observed in operative removal. The relations of the supernumerary fingers to the metacarpal radiations should be established by means of the X-ray (Fig. 44c), as this frequently furnishes information as to which finger is really supernumerary or which is the duplex radiation.

The plastic treatment of the thumb requires special care on account of its great functional value.

Surgical interference is more urgently indicated in syndactylism, but not alone for cosmetic reasons. The growth of the webbed fingers is considerably affected, especially when several are grown together. The
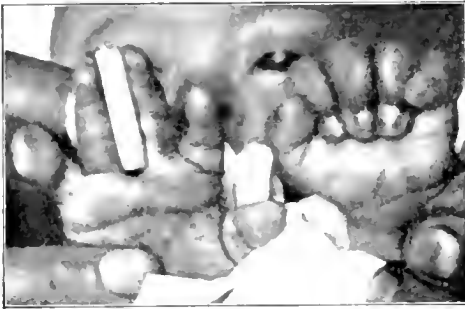

Fig. 45a.

Fig. 45b.

Fig. 45a.—Syndactyl of third and fourth fingers and application of separating instrument. Child six weeks old. The connection between second and third and fourth and fifth fingers has already been separated by the bloodless method.

Fig. 45b.—Separation is complete after wearing the instrument 14 days (by tightening the screws every other day).

degree of deformity varies from a thin web formation between the fingers to a broad fibrous and sometimes bony connection of the phalanges. The skin passes over the webbed fingers without a groove in the most severe types and even the finger-nails do not appear to be separated.

The main object of the treatment is the separation of the connected parts. The greatest difficulty is in covering the separated surfaces with skin because of the tendency of the point of adhesion to press itself forward without the formation of a natural commissure. The introduction of sutures and the gradual tying off of the connecting tissue is often followed by regrowth of tissue from the point of connection. Plastic flap operations are performed to overcome this annoying complication. Alternate flaps are made from the dorsal portion of one finger and the ventral portion of the other so that the separated surfaces will be covered. Zeller sought to protect the point of commissure with a small dorsal skin flap the length of the first phalanx, the dissection of which

was made so that the base was at the commissure and apex at the level of the first interphalangeal joint, and the flap was finally sutured towards the vola manus.

Great difficulties are encountered in all such operations on account of the small space and deficient skin material.

FIG. 45c.
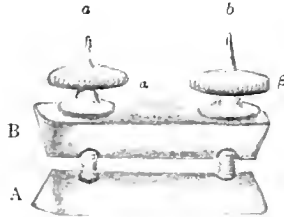
Two wedge-shaped metal bars connected with each other by means of screws *a* and *b*. The screws are fastened to the bar A, and the bars are approximated by turning the screw tops *a*, *β*. In adjusting the instrument the bars are taken apart, a perforation is made with the one pointed screw-top at a point a little proximal to the further commissure, with the instrument and the other screw protruded above the tip of the fingers. Bar B is put on now, and, by turning the screw tops *a*, *β*, a light pressure is exerted upon connecting tissue of the webbed fingers.

One finger generally remains uncovered and the subsequent cicatricial contractions impede the freedom of action.

The author uses a small instrument to keep the fingers apart. Two movable metal bars of triangular shape (Fig. 45c) are placed so that

FIG. 46.
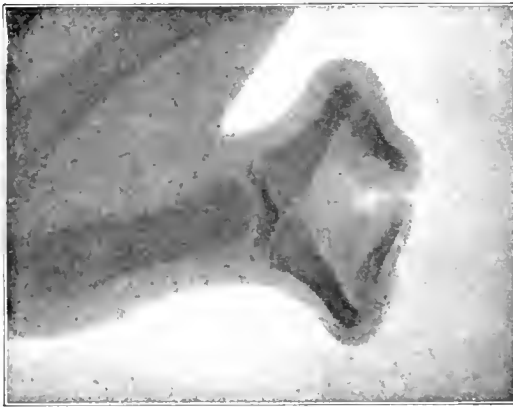
Pollex duplex. Both thumbs are connected with the surface of a saddle-shaped metacarpal joint, and face each other like a pair of forceps.

their edges exert a dorsoventral pressure on the tissues which are to be separated. They are very slowly approximated, one rotation or even less of the thumbscrew daily until a groove gradually forms which later changes into a web. The separation is accomplished when the instrument falls out. Small sores, the result of pressure, can easily be prevented and will heal without much trouble from cicatrices. A cor-

rection can be made later with the aid of Zeller's plaster flap operation should any adhesions occur. The results of this procedure are good and the treatment simple and easily carried out, even in out-patient practice, which is important with young infants.

In oligodactylia several or even all the fingers are absent. There may be a defect in the radius with a missing thumb or a defective ulna with the little finger absent.

Such deformities are often associated with webbing of the existing fingers (cleft hand, forceps hand).

Operative measures vary according to the conditions present.

Inclination of the fingers towards each other is caused by different pathological variations. A change in the direction of the axis of the fingers has been occasionally observed (clinodactylia).

The thumb displays many variations. Formed in duplicate each thumb may be attached to its own metacarpus or both may articulate with one metacarpus.

The thumbs may be webbed or stand in opposition to each other like the blades of a pair of forceps (pollex varus).

Thumbs with three joints are occasionally found.

Congenital differences in the size of fingers are reported as well as a giant growth of a single finger or certain parts of them. There are a thousand differences and combinations which may be manifest in the final development of an organ when for some reason or other such development deviates from its natural course (macrodactylia, brachydactylia).

II. CONGENITAL DEFORMITIES OF THE LOWER EXTREMITIES

A. CONGENITAL DISLOCATION OF THE HIP (LUXATIO COXÆ CONGENITA)

This is the most frequent of all congenital dislocations. Girls are affected more commonly than boys and the ratio is about seven to one. Sixty per cent. involve one side and forty per cent. both sides (Hoffa).

Of all congenital deformities this one has given rise to more diverse opinions and arguments with regard to pathogenesis and treatment than any other. Few chapters of modern orthopædics can show such a record of magnificent results.

The etiology and pathogenesis of this affection have not yet been entirely cleared up, although the pathologic and anatomic details are well known and have been minutely described. There are, however, three points which should guide us in our consideration of the different theories:

1. Congenital dislocation of the hip occurs in different members of the same family and is hereditary and is often combined with other congenital malformations.

2. It is much more common in the female than in the male sex.

3. Races developed to a higher degree from an anthropological view-point suffer more often from this affection than the inferior ones.

The ratio of dislocations of the hip and births is 5 : 1000 in the female and 1.5 : 1000 in the male. The displacement occurs very rarely in the female negro and about ten times less often in the Mongolian female than the European (Le Damany).

None of the theories so far advanced can satisfactorily explain the above-mentioned facts. Injuries before birth, adhesions, and constrictions during the germinal stage of development, great narrowness of the womb, too great flexibility of the foetus, arrest in the development of the joints, etc., can furnish an explanation for only some of the cases. Their occurrence certainly favors the development of intra-uterine dislocation, but can never furnish a general basis for the etiology.

Le Damany considers the embryonic and pathologic details of this deformity from a biological viewpoint. The hip-joint (socket, head, and neck) is in reality formed for a quadruped and has not yet adapted itself to the erect carriage of a human being. The socket extends too far forward, while the thickest part of the border of the acetabulum which forms the upper border in a quadruped is located on the posterior side. The upper border in a human being is weak and cannot enclose much of the circumference of the head on account of its oblique position facing toward the front.

In adapting itself to the position of the socket and the resulting upright gait, the neck is markedly distorted to the front (antetorsion, Fig. 47).

Antetorsion increases with the growing development of the human race, being less marked in prehistoric man with bent gait (see Coxa vara).

Furthermore, the broad pelvis of the white woman must be mentioned in addition to these difficulties, as it must adapt itself to the head of the foetus. The highly cultured white races need a larger brain and this calls for a larger skull which requires a wider pelvis for passage at birth. The female pelvis is larger at birth than that of the male. The head of the femur can be forced away from the acetabulum by the position of the foetus before birth. Heredity and occurrence in families are of importance.

Faulty development of the acetabulum, hypertrophy of the pelvic floor, and aplasia of the acetabular roof and femoral head may predispose to this condition.

Congenital dislocation of the hip is therefore a deformity produced by a combination of several factors. It is an insufficient adaptation to an anthropological fact of comparatively recent date (erect position and gait). Anthropological evolution and the attendant pelvic changes are to be considered the main factors in the production of this deformity.

In discussing the **pathological anatomy** the fact must be borne in mind that we are dealing with a displacement of articulating bodies within the capsular cavity and not with a complete dislocation. Each part of the joint shows changes, either of primary origin or produced by later growth and usage of the faulty joint.

The most noticeable feature is the flatness of the acetabulum, which appears to be caused by a diminution in depth on account of filling up with fibrous tissue (hyperplasia of the acetabular fundus). The younger the acetabulum the more it resembles the normal (Bade). Later on it loses its depth as well as its semicircular form and becomes triangular (Hoffa). In these cases of dislocation the acetabulum points more to the front and is located nearer to the obturator foramen. The older the dislocation the greater are the changes in the disused acetabulum. It often happens that new acetabular-like formations are created (near-

Fig. 47.
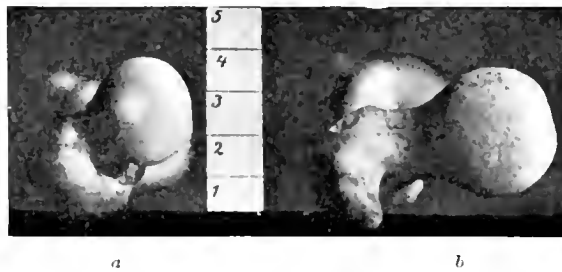
Head of femur of a newborn (a) and of an adult (b), photographs of equal dimensions. Antetorsion elevation from the table (on which both condyles of the knee and trochanter are resting) is markedly greater in a than in b.

throsis) at the point of contact of the head and pelvic bone. With the exception of a marked antetorsion the femoral head shows no further changes in a juvenile dislocated joint. It projects more than normal above a plane passed through the trochanter and the condyles of the femur. Antetorsion of forty degrees in a newborn infant usually changes to the normal antetorsion of twelve degrees in a couple of months. This remains and is often increased in a dislocated head. On account of the deficient normal weight and radius of motion retrogression of the antetorsion is lacking. Later variations in the appearance of the dislocated head are secondary and the result of demands made upon it. As a result of deficient weight the bone becomes atrophic, the neck does not develop further and remains short. The head may assume a great number of different forms from gliding and sliding over the surface of the pelvic bone. The weak bone when forced to bear weight often changes in position, producing a coxa vara. This is caused by the formation of nearthrosis or by being surrounded by strong ligaments.

The capsule of the joint is distorted into a tube by the separation of the articulating bodies. It surrounds the acetabular border and contracts further on in an hour-glass fashion (isthmus) and at the upper end dilates again for the purpose of surrounding the head. The ligamentum teres forms part of this capsular tube, and in older dislocations it often becomes atrophic and sometimes entirely disappears (Hoffa). In other cases it may be greatly hypertrophied.

The muscles and ligaments surrounding the hip must also adjust themselves to the changed position of the articulating bodies. Their hypertrophic condition is due to their great importance in bearing the

FIG. 48a.—Congenital dislocation of the left hip. Girl four years old. Demonstration of the Trendelenburg symptom. Standing on the left dislocated leg the pelvis is tilted downward.
FIG. 48b.—Standing on the right sound leg the pelvis can be elevated.

weight of the body on account of the lowered resistive power of the bones. The adductors are apparently shortened, a result of their femoral insertion being forced higher up as well as the weakening of their antagonists the gluteal muscles, whose insertion higher up the trochanter tends to reduce their function as lever to a minimum.

Symptomatology.—The limping gait is the most conspicuous symptom. It occurs in both unilateral and bilateral dislocations and is caused by the insufficiency of the gluteal muscles to effect abduction of the leg or to raise the pelvis when standing on one leg.

Under normal conditions one can by standing on one leg and elevating the other not only retain the pelvis in a horizontal plane but even raise it several inches (action of the gluteus medius, Fig. 48b).

In cases of displacement of the point of femoral insertion further upward the vertical or elevating component of the muscle grows smaller and its strength is not sufficient to hold the pelvis in a horizontal plane, as it has exhausted itself in pressing the neck against the pelvis (horizontal component).

When the child stands on the dislocated leg the pelvis will tilt downward on the unimpaired side as soon as an attempt is made to lift the sound leg from the ground. This is called the Trendelenburg symptom (Fig. 48a). The upper part of the body is inclined to the affected side so as to avoid falling.

FIG. 48c.

Reduction of patient in Fig. 48 across the posterior border of the acetabulum.

The limp in unilateral dislocations, as well as the waddle in bilateral cases, may be considered to be a continuous symptom of Trendelenburg. Moreover, as a result of insufficient support the head of the femur rolls and slides up and down over the iliac bone and the body relaxes slightly with each step as if the ground under the patient were unexpectedly giving way. The upward and downward movement of the projecting trochanter can be easily recognized when the patient is undressed.

The inclination of the body toward the affected side tends to become more marked and the steps more unequal. The child avoids bearing its weight on the unsteady leg. When standing on the sound leg the motion of abduction with the diseased one is impaired. As the child grows older the contraction due to adduction increases and is very troublesome, especially in bilateral dislocations.

Examination from behind a child with unilateral dislocation and

standing erect reveals a shortening of one leg. The pelvis is tilted downward on the dislocated side. In small children it is especially noticeable in the gluteal and other cross-folds of the leg. There is also a compensatory scoliosis.

In bilateral dislocations we find a pronounced lumbar lordosis. The pelvis assumes a more vertical position on account of the location of the heads of the femur, which are forced upward, and the lumbar portion of the spine forms a marked compensatory anterior curvature (Fig. 49a, Plate 6).

The chief subjective symptom is the impairment of gait. The child usually does not at-

Fig. 48d.

Fig. 48e.

Fig. 48d.—The same position as in Fig. 48e with first plaster bandage in position.
Fig 48e.—Second bandage in inner rotation, showing crutch.

tempt to walk until the end of the second year. The disproportion of the legs and the unequal range of motion are often noticed by the mother at an earlier age. The increasing weight of the body intensifies the limp, and walking is often accompanied with severe neuralgia of the stretched sciatic nerve.

The **examination** enables us to detect the symptoms mentioned above and to confirm the diagnosis. A radiograph is an important aid in making a diagnosis. It is not always easy to get a satisfactory picture

in young children, as their epiphyses are cartilaginous. The family physician should make as early a diagnosis as possible so that appropriate treatment can be applied. The following cases will illustrate the importance:

CASE 1.—A child of eighteen months cannot walk well. The mother states that the child never had any pain, began to walk when fourteen months old, has a limping gait, tires easily, and appears to stand mostly on one leg. On examination it is found that the child limps on the left side and that the body is inclined towards the left. The left gluteal fold is lowered. The region of the trochanter is marked for identification and a line drawn from the anterior superior spine of the ilium to the tuberosity of the ischium (Roser-Nélaton line). On the left side the trochanter is located above this line; on the right side below it. Grasping the femur with one hand and the pelvis with the other, one can readily feel the left femur gliding in a longitudinal direction along the pelvis. On measuring the distance from the anterior superior spine to the internal malleolus, we find a shortening of about two centimetres on the left side. Pulsation of the femoral artery can be distinctly felt beneath the inguinal ligament on the right side, and pressure with a finger a little to the outside of this artery reveals a resistance which increases on overextending the femur and rotating it outward. This is the head of the femur. This resistance cannot be detected on the left side.

When the child walks the upward and downward displacement of the contour of the trochanter can be seen. When the child runs the limping decreases as temporary compensation takes place owing to acceleration of the movements. While standing on the left leg the pelvis is tilted downward on the right side and when standing on the right leg the pelvis is held horizontally on the left side. Diagnosis: Dislocation of the left hip.

CASE 2.—A child three years old. The mother states that several members of her family limp. The child started to walk when eighteen months old and has ever since waddled in a most peculiar fashion. Examination revealed a marked lumbar lordosis combined with a slight scoliosis to the left. While walking she swings the upper part of the body to and fro, more towards the left than to the right side.

Trendelenburg's symptom is present on both sides. Inspection from the front shows a prominent abdomen and backward displacement of the pubic region. It is found that on lying down there is a slight shortening of the left side. The legs are spread wide apart—only with difficulty. The trochanter is located above the Roser-Nélaton line on both sides, the left one higher than the right. The head cannot be palpated beneath the femoral artery on either side. Diagnosis: Bilateral dislocation of the hip, the left head standing slightly higher than the right.

PLATE 6.

FIG. 49a.—Bilateral congenital dislocation of the hip (boy five years old). Marked lumbar lordosis.

FIG. 49b.—Plaster-of-Paris cast in primary position (Case 49a) after reduction. Duration three months.

FIG. 49c.—Plaster-of-Paris cast applied in secondary position (Case 49a). Duration two months. The third and fourth casts were applied with legs in inward rotation. Duration two months each time.

Case 3.—A girl-baby three months old. The mother states that one leg is shorter than the other, that the baby does not move it as freely as the other and that it is somewhat thinner. The folds do not correspond on the two sides, especially the femoral fold at the origin of the sartorius muscle. An attempt to palpate the head reveals an empty acetabulum beneath the pulsating artery. The head is displaced upwards toward the anterior superior spine. Diagnosis: Unilateral congenital dislocation of the hip forwards and upwards (luxatio supracotyloidea).

Case 4.—A girl twelve years of age limps heavily on the left side. She steps with the right foot more quickly than with the left and walks on her left toes. On examination she presents a marked scoliosis to the right which is compensated upon assuming the sitting position. The left gluteal fold is located higher up, because the child stands mostly on the sound leg and tilts the pelvis upward on the opposite side for the sake of stretching the legs parallel to each other and overcoming the contraction due to the adduction of the diseased leg. Abduction of the affected leg is difficult except when the body is flexed to the right side. The trochanter stands high near the crest of the ilium and moves when the leg is moved. Measurement in the recumbent position discloses a 7 cm. shortening of the left leg, which cannot be adducted or entirely straightened out. Rotation and flexion are free, passive motions are painless, and no resistance is palpable beneath the artery. The child can jump with the sound right leg, but not with the left, as the foot appears to be fastened to the ground. Diagnosis: Dislocation of the left hip (luxatio iliaca) with shortening and contracture of the left leg.

A comparison of these four cases will enable one to make a more accurate differential diagnosis than could be formed by enumerating the different points.

If possible a radiograph should always be taken, as it will reveal the shape of the bony acetabulum, the form of the head, and the position of the head to the acetabulum. But we must bear in mind the possibilities of mistakes in regard to—

1. The shape and size of the fibrous acetabulum (fibrous hyperplasia of the acetabular fundus), because fibrous tissue does not throw any shadow.

2. The form of the head and neck in case the legs are not stretched out parallel to each other and in case both patellæ do not face upward. These conditions distort the picture and give a false idea regarding the position of the head, neck, and shaft. The only possible way to form a definite opinion of the extent of antetorsion is by radiographs taken with the legs in inward rotation (Figs. 49d, 49e, Plate 7).

3. The relation of the head to the acetabulum. A displacement in the sagittal plane is not disclosed in a radiograph.

Caution should be exercised in making a diagnosis of dislocation in infants from the radiograph. In the first place the epiphyses which are cartilaginous throw no shadow in comparison with the ends of the diaphyses. There is also a slight difference in the height of the articulating bodies.

A congenital predisposition to dislocation is the chief cause of this condition. The head of the femur takes a position near the acetabulum, more often in front or above it (Lange) but occasionally behind (Hoffa). The increasing weight forces the head gradually further upward and backward so that in the older dislocations we generally find a luxatio iliaca (Spitzy).

Differential Diagnosis.—I. *The Waddling Gait in Rickets.*—Curvatures of the neck (coxa vara) and of the shaft produce an elevated trochanter. This will cause a limp and a marked lordosis and also the Trendelenburg symptom. The gait, however, is much more steady than in dislocation. The displacement of the head is lacking and it is palpable beneath the femoral artery. The Röntgen ray will establish the diagnosis.

2. *Coxitis.*—In this disease the head is firm either in part or in toto. Passive motion is painful. The leg becomes rigid and is dragged on account of the effort to avoid movements in the hip. The steps are unequal. The Trendelenburg symptom is absent and the head is palpable beneath the artery. The surrounding tissues are swollen and painful on pressure, owing to exudation in the joint.

In cases where severe destructive processes have forced the head out of the acetabulum (pathological dislocation) the history and a careful examination will prevent mistakes.

3. *Paralytic Dislocations.* — Separation of the articulating bodies takes place in paralysis of the gluteal and pelvic muscles. The stronger muscles press the head against the acetabulum (see Paralysis of the deltoid).

4. *The Similar Gait in Spinal Muscular Atrophy, Muscular Dystrophies, and Spastic Paraplegias.*—Careful examination reveals a normal condition of the articulating bodies provided it is not combined with rigidity due to a spastic state of the muscles (Gaugele).

The **prognosis** in a case of congenital dislocation of the hip is unfavorable, since a spontaneous cure never occurs. It is not possible to outgrow the deformity, but Drehmann has reported cases where recovery took place in slight subluxations. The increasing weight of the child tends to push the head further away from the acetabulum. Shortening increases the adductor contraction and tends to twist the femur inwards. In bilateral deformities this is apt to lead to severe functional disturbances. Compensatory scoliosis is generally not of the fixed type, on account of the constant counterpoise of the body when walking or sitting.

PLATE 7.

Fig. 49b.—Radiograph of case in Fig. 49a taken in normal position with feet together and patellæ facing to the front. Marked anteversion of the femoral necks, which appear greatly shortened. Acetabulum on both sides is flat. The heads are located to the side and above the acetabulum, similar to conditions existing in a dislocation of the ilium.

Fig. 49c.—Radiograph of case in Fig. 49a after nine months of treatment by retention. On account of the inward rotation of the legs the anteverted femoral necks are fully exposed to view. The heads are located in the central part of the acetabular fundus (central reposition).

An erosion of the ileum may occur above the old acetabulum to such an extent that the head finds a new support and a false joint is produced.

The dislocation in the newborn is not very pronounced, but treatment is imperative as soon as it has been correctly diagnosticated. The author succeeded in four cases of unilateral dislocation of the hip (subluxation) in preventing a complete dislocation (luxation) by the use of constant extension, using weights up to one kilogram (2.2 pounds) and preventing the child from bearing the weight of its body for two years.

Most of the cases coming under observation are over two years of age, since the peculiarities of gait become apparent about that age.

The ideal form of **treatment** is the bloodless method of reduction introduced by Lorenz. Pravaz and Paci had previously attempted to reduce the dislocated joint, but reluxation occurred owing to insufficient fixation. Lorenz placed the bloodless method on a sound basis. His method has undergone modification and changes at the hands of different surgeons, but they do not change the important features of his operation, namely, reposition and retention.

Reposition.—The child is placed in deep narcosis on the edge of the operating table, the dislocated hip on the outside. An assistant fixes the leg, preferably by strong flexion of the sound leg. The head is then pulled downward by traction on the femur. Where there is marked shortening, extension weights gradually increasing up to 20 kilograms (44 pounds) are applied for one or two days before the operation.

Resistance from shortening of the muscles and fascia must be over-come in pulling the head downward. Lever-like motions are necessary to overcome this resistance. Flexion and abduction tighten the shortened muscles while forced adduction and massage relax them. Reduction may now be accomplished, especially in cases of subluxation forward and upward, by means of forced extension, light pressure on the trochanter, and inward rotation (reduction across the upper border of the acetabulum).

In many cases it is necessary to employ the lever motions across the posterior border of the acetabulum. The leg is flexed to right angles and then extended. The thigh is gradually abducted more and more while the thumb of the other hand or the underlying fist presses against the trochanter (reduction across the posterior border of the acetabulum) (Fig. 48c).

In difficult cases Lorenz makes use of a padded wedge of wood which he places beneath the dislocated hip for the purpose of facilitating the reposition. Manual reduction is less irritating. If this does not succeed, an attempt should be made at reduction across the lower border of the acetabulum with motions similar to those made with a pump-

handle (Hoffa). The abducted leg bent at right angles is pushed in a horizontal plane to and from the body. Pressure on the knee in marked flexion and adduction forces the head across the lower border of the acetabulum.

When the head slips into the acetabulum a characteristic and typical snap is heard. The head can then be plainly felt beneath the femoral artery. This snap is not very distinct in the flat cartilaginous acetabulum of young children. The head can be felt at this point projecting in hemispherical form on increasing the abduction and hyperextension. It does not remain in this position long, but with a perceptible motion it slips away from the acetabulum. The stability of the head varies and is mainly dependent on the depth of the acetabulum and the interposition of tissue (capsule, ligamentum teres).

Retention aims to fix the head in the most favorable position.

This is best accomplished by applying a tight-fitting plaster bandage which encircles the pelvis and femur. Surgeons differ in their methods as to the primary position of the head and the extent of the bandage.

The author applies the bandage in a position which insures the greatest stability to the head. Only a small amount of padding is used and the bandage is extended up to the border of the ribs and downward to below the knee (Fig. 48d). Flexion from 70° to 90° is made with a somewhat greater degree of abduction. In order to increase the stability it is sometimes necessary to antevert the femoral neck and rotate it inwards. Children bandaged in this manner can walk on the ball of the foot with the heel raised. It is better not to allow the child to walk on the feet but rather to build in a crutch in the femoral part of the bandage Fig. 48e) with which the child soon learns to walk (Codivilla). This enables the child to walk with an even more pronounced inward rotation.

The first cast should remain in position for three to six months. If there is any doubt as to the retention the cast should be removed and the position examined by the Röntgen rays. A radiograph can be made without removing the entire cast bandage by cutting out windows in the bandage (Klapp). If the position is satisfactory no change should be made until the period of fixation (three to six months) has elapsed. The plaster bandage is then gradually and carefully readjusted to the normal position. Under the guidance of the X-ray this can be accomplished without the head slipping out of position. A second cast is required in nearly every case, depending on the amount of stability and the condition of the head and acetabulum. Each case must be considered individually, for mechanical routine in every case is impossible.

The duration and position of the second cast depend entirely on

PLATE 8.

Fig. 50.—Pathological dislocation in coxitis   The badly eroded head is separated from the shaft at the neck, forming a sequestrum in the likewise severely eroded acetabulum.   The trochanter is located upward and stands far above the upper border of the acetabulum.

the case. The length of treatment is generally from five to twelve months and even longer. When a satisfactory stability has been attained the bandage is removed and the child encouraged to make active motion. Weights may be carefully used when the unrestrained motions have returned the leg to a natural position. Force should not be applied. When the child begins to walk the sound leg is raised by building up the sole of the shoe. This insures the maintenance of abduction in the affected leg.

Bilateral dislocations of the hip are generally reduced at one sitting and fixed by means of a corresponding cast. The treatment with the plaster-of-Paris bandages takes longer than in unilateral dislocations (Fig. 49, Plate 6).

The **after-treatment** consists of active gymnastic exercises, especially in abducting the leg and strengthening the muscles which support the pelvis. It is advisable to have the children wear a support around the pelvis at night, which will hold the head in the joint. Reiner and Lange advocate wearing pelvic rings made of celluloid and steel wire.

Resulting contractions may be overcome by elastic traction, yet it is better to rely more on time than on forceful manipulations. The natural desire of the child to increase the function is certainly much safer.

This describes in a general manner the bloodless method of treatment in congenital hip dislocations in the Children's Hospital at Gratz, and it differs only in minor details from that advocated by Lorenz.

The most satisfactory *age* to reduce these dislocations is from one and a half to three years. The wetting and soiling of young children gives much trouble, but treatment should not be deferred on this account. The upper limit of age is of more importance. Secondary changes increase so rapidly that a fairly normal establishment of function seldom occurs later than the ninth or tenth year, even if the dislocation has been successfully reduced.

In bilateral dislocations the upper limit of operative procedure is reached more rapidly on account of destructive processes producing stiffening of the joint. This is due to the closing up of the unequal articulating bodies. The upper limit in these cases is from the fifth to the seventh year. The employment of new methods has occasionally resulted successfully in older dislocations (Becher, Reiner, Lange).

It is impossible in some cases to retain the head entirely in the acetabulum. Very often it slips out of the acetabulum over the anterior border and remains below the anterior superior spine. The tendon of the rectus femoris muscle passes over it and in conjunction with the spine forms a support (subluxation, transposition).

A reluxation backwards seldom occurs after treatment by the present technic.

The **results** are exceptionally good. There have been reported over 80 per cent. of anatomical cures. It must be borne in mind that deceptive results may occur, in that the function in transposed joints is often much better than in anatomical reposition (especially in older joints).

Changes may occur in the reduced hips as a result of the inability of the atrophied head and neck to carry the weight of the body. The

FIG. 51.

Congenital deformity of the femur. Child fourteen months old. Hip is normally developed and flexible, no cleft in the knee-joints, the short bowed and curved femur passes directly over into the tibia. Lower extremity and foot are otherwise normal. Treatment: osteotomy to straighten the femur and splints.

acetabulum being much firmer may grind off the head and force the neck to assume a varus position (Fröhlich).

The so-called **bloody operation** may be attempted in case reposition and retention are unsuccessful. This is the older method and was inaugurated by Hoffa and most of our anatomical knowledge of this condition is derived from it.

The strong forces of development during the first years of life give ample possibility to influence the growth of the tissues and change the direction in which they are growing. The results which have been

attained by conservative measures prove that complicated operations should be advocated only in exceptional cases.

Treatment by means of apparatus alone is antiquated and should be absolutely prohibited in children.

B. CONGENITAL COXA VARA
(See page 167.)

C. CONGENITAL DEFORMITY OF THE FEMUR

Cases have been reported of absence of the entire lower extremity due to disturbances of development. Deficient development of the femur may involve different parts of the bone and the appearance of these cases varies accordingly. On account of the accompanying curvatures and axis-deviations, the treatment of these deformities is in part operative and in part prosthetic in order that the patient can walk in a fairly normal manner.

D. CONGENITAL DEFORMITY OF KNEE-JOINT AND LEG

Congenital malformations of the knee are of rare occurrence. Deformities of the patella are generally found combined with other abnormalities. The patella, which is in reality simply a sesamoid bone, varies greatly in its size and shape and is dependent on the development and activity of the muscle and tendon in which it is imbedded. This is the reason we find small patellæ in cases of club-foot—due to deficient action of the muscles. Bogen describes a case of dislocation and very small patellæ in one family where the mother, children, and grandchildren exhibited the same abnormality. The patella is exceptionally small in congenital dislocation of the knee, yet with an increase of function it may grow and attain its normal size.

Congenital dislocation of the patella is similar to displacement of the tendon of the quadriceps muscle.

Outward dislocation, which occurs most frequently, produces functional disturbances in older children. There may be inability to extend the leg fully on account of the faulty action of the quadriceps muscle, which, together with the patella, appears to have slipped off the femoral pulley. This deformity is sometimes found in members of the same family. The author has found heredity in six out of sixty-eight reported cases.

Therapeutic measures are necessary when the dislocation cannot be reduced, thereby preventing perfect extension of the knee and giving insufficient support to the weight of the body. In the cases of sudden dislocation which disappear spontaneously or by manual reduction, some disturbance in gait and impaired function of the joint often remain and require treatment and relief. When the dislocation is combined with

marked genu valgum, the correction of the genu valgum will generally eliminate the patellar dislocation, on account of its tendency to produce secondarily such a dislocation. In other cases the capsule is doubled in on the internal side according to the method of Le Dentur or Hoffa, or, following Ali Krogius's suggestion, a loop is cut out of the external capsular wall, drawn across the patella, and anchored in a previously prepared fissure in the internal capsular wall. Roux performs an osteoplastic operation in very pronounced cases, grafting the insertion of the patellar tendons upon the inner surface of the tibia.

Dislocation of the knee forward (genu recurvatum congenitum) is the most frequent form (Fig. 52). This produces marked disturbance

FIG. 52.

Congenital bilateral "back-knee." Microcephalic child, fifteen months old. Very marked right club-hand (manus vara) without deformity of the right forearm. Club-feet.

in the movements of the knee-joint. The action of the shortened quadriceps muscle prevents flexion when the leg is overextended. The tibia rests on the anterior articulating surface of the condyles and the smooth cartilaginous lining is lacking in the posterior surfaces. A tumor representing the projecting posterior surfaces of the condyles is palpable in the popliteal space. The patella is generally very small and the capsule of the joint, although uninjured, is greatly distended posteriorly. The displacement of the insertions of the muscles interferes with muscular mechanism to such an extent that the flexors become extensors and increase the deformity.

From an **etiological** standpoint we are dealing with an embryonic anomaly in growth, which generally arises from pressure and fixation of the extended leg with the thigh flexed at the hip against the abdominal surface of the body. This condition is due to narrowness of the uterus, small amount of amniotic fluid, fixation by the umbilical cord or by amniotic bands. Various symptoms (popliteal folds) indicate that fixation even in later embryonic life is sufficient to bring about disturbances in growth. The frequent occurrence of the deformity in one family, as well as its repeated combination with other malformations (spina bifida, disturbances of the hip, club-foot), proves that primary developmental disturbances are an important factor, although inherited narrowness and lack of space may also cause further deficient development.

The **prognosis** is favorable in so far as that there will be no further progress of the ailment. Joachimsthal has reported cases in which there had been a spontaneous improvement in motion.

The **treatment** is more effective in cases seen early when apparatus can be applied to limit the flexibility of the joint. But in most cases the tension is too great to overcome without resorting to reduction by operation. Hubscher elongates the tendon of the quadriceps muscle in the form of steps and makes a subcutaneous reposition after a transverse incision is made through the anterior capsular wall.

Congenital Deformities of the Leg.—Total or partial defects of both bones occur as in the forearm. They cause fixation and faulty position of the foot. For example, a defective fibula is accompanied by marked pronation in the astragalus joint, and the fifth toe may be missing.

The **treatment** of such deformities consists in osteoplastic operations—substitution of the tibia by the fibula—and in some cases in the employment of prothesis.

The so-called **Volkmann's deformity of the astragalus joint** consists of an outward distortion of the foot where both bones of the leg are intact. This is a rare occurrence.

E. CLUB-FOOT (PES VARUS)

This is a condition in which the foot is fixed in a supinated position, the inner border turned upward and the outer border turned downward. The end of the foot is inverted and at the same time tilted downward.

Congenital club-foot (pes varus congenitus) is the most frequent of all deformities. Bessel-Hagen's statistics show that it occurs once in every twelve hundred births. It is found more frequently in boys than in girls and is bilateral in over half the cases. More than one-tenth of the cases are combined with other deformities.

Etiology.—A large number of cases can be traced back to primary developmental deformities. The etiological factor seems to be inherited. Joachimsthal reports a case where a father and his three children were all afflicted with club-feet.

Inherited narrowness of the uterus, as well as other individual conditions, induces the formation of club-feet; although it would correspond more to the modern biological way of reasoning to look upon these factors as exciting causes only, than to assume that one or both feet had been forced into such a narrow space or loop as to become firmly fixed in that one position.

Cases which show Volkmann's pressure points and constriction in the pathological position after birth are of rare occurrence.

Not infrequently a club-foot is combined with a flat-foot on the opposite side, due to pressure in that position in utero, and the feet retain the same position after birth.

From that pathological-anatomical standpoint it is evident that fixation of the foot in a certain position must cause corresponding changes in the bones and ligaments and force the muscular apparatus to adapt itself to the new functions. The bones are almost pressed together on the concave side, diminished in size and condensed in tissue. On the convex side they appear swollen, enlarged, and rarefied. The neck of the astragalus is longer on the outside and points inwards and obliquely. The anterior process of the calcaneus is elevated and the upper articulating surface inclines obliquely in a median direction. The entire longitudinal axis of the calcaneus shows a concavity on the inner side, and its articulating surfaces incline in the same direction and the cartilaginous covering is displaced accordingly.

When the conditions persist for a long time the disused cartilages disappear entirely and obstructions form which do not allow a return to the normal position. The further growth tends to increase the deformity.

The ligaments naturally adapt themselves to this position and the development of the muscles also undergoes changes corresponding to the restriction of motion. The muscles of the calf of the leg are affected the most, for little work is left for them as the foot is generally in a position of extreme plantar flexion. The greater part of the gastrocnemius muscle moves upward, just far enough to permit of sufficient contraction to perform the small amount of motion allowed by the fixation.

The **symptoms** are derived from the pathological anatomy. The foot is supinated, the inner border elevated and the outer lowered. In addition there is adduction of the front part of the foot, which is turned inward to the extent of 90° or more. Necessarily combined with these symptoms is a plantar flexion resulting in distortion of the foot and

marked exaggeration of the arch. This can be readily seen from an impression of the sole of the foot.

Locomotion is restricted on account of the small range of motion. The children walk on the outer border of the foot and compensate the inward rotation of the foot by rotating the leg outwards at the hip. The knee tends to become more rigid and fixed so that the leg is used as a stilt. The quadriceps muscle becomes atrophied from disuse (see Small-ness of patella, page 119). The pathological position increases with the weight of the body, and in the more pronounced cases the patients walk almost on the dorsum of the foot, the entire sole facing backward and the toes inward and even backward (Figs. 53, 54, 55).

The **diagnosis** of club-foot is not difficult. The rigid fixation differentiates it from the not infrequent supinated foot of the newborn as well as the club-foot acquired later. Muscular disturbances caused by paralysis and cicatricial contractions resulting from injuries may produce club-foot positions; but the fixation is never as typical and pronounced as in congenital club-foot. The history will differentiate it from similar affections.

The **treatment** of congenital club-foot depends entirely on the degree of deformity and whether it exists in newborn or walking children. The social environment of the child is a factor in the treatment, as

FIG. 53a.

Bilateral congenital club-foot. Newborn baby. (An older sister has a left club-foot.) Marked varus position, the sole faces backward. Pronounced short-ening of the plantar fascia and tendo Achillis.

minute attention and care are essential in the protracted bloodless treatment of this condition. Orthopædic dispensaries can show what harm may be done by the neglect of ignorant parents. In case the child can be kept in a hospital for the necessary time, or can receive careful, intelligent nursing at home, the early treatment of club-foot by the von Oettingen-Fink method is very efficient.

This treatment is preferable to the vague suggestions of other authors, which so often consist in simply telling the mother that she should attempt to overcome the trouble by correcting the faulty attitude by daily massage. Before applying the von Oettingen-Fink bandage treatment I always attempt to mould the foot into a normal position without anæsthesia. The os calcis is grasped with one hand while the other corrects the adduction of the front part of the foot. The malleoli are then held firmly and the foot pronated with lever-like motions. Special

care should be taken to place the heel in a pronated position. Finally
the equinus position is corrected, which can be easily accomplished with-
out tenotomy in the newborn. At the same time the heel should be
pulled downward and the correction not done exclusively in Chopart's
joint. The foot, having been made limber after various movements, is
then encased in a von Oettingen-Fink paste bandage. The thigh, leg,
and foot are painted with the paste,[1] over which the bandage is applied
in the following manner: A soft bandage is fastened around the middle
part of the pronated foot, starting from the outer border of the small
toe, passing over the dorsum and running across the sole, thus enabling
the foot to be strongly pronated by traction (Fig. 53b). From the
over-pronated foot the bandage takes its course along the leg up to the
knee, which is flexed at right angles, and thence to the lower third of the

FIG. 53b.

Paste bandage introduced by v. Oettingen-Fink. Replace-
ment fully accomplished; the bandage is fastened to the outer
border of the little toe (a) and run over the dorsum to the sole,
effecting pronation; the picture shows how the bandage is fastened
to the middle of the thigh.

thigh. It then runs along
the popliteal space to the
outside of the leg and ter-
minates after several spiral
turns at the inner border of
the foot. Similar traction,
but somewhat distal to the
first so as to include the
great toe, is now made in
order to increase pronation.
This bandage runs parallel
to the first up to the thigh,
where it is fastened and
then turned back again
along the leg in spiral turns
to the inner border of the
foot, including the heel,
ending finally at the thigh above the knee and in front of the first
bandage. The bandage (Fig. 53c) is finally fixed by several circular
turns. It must not be applied too tight so as to produce anæmia or
too much stasis. If there are points of pressure, small cotton pads may
be inserted around these points. The bandage should be protected
against wetting by using Billroth's batiste pads. These can be changed
in one or two days or renewed by the mother when necessary. The
foot must constantly be held in an overcorrected position when the
bandage is renewed. At the time of renewal the skin should be cleansed
and stimulated.

The advantage of this treatment lies in the exceedingly simple technic.
Fairly intelligent mothers are kept at our clinic and taught the methods

[1] R Colophon. 50, mastich. 25, alcohol (95%) 360, terebinth. 30, res. alb. 15.

of treatment, and supervision of their work later on from time to time is all that is necessary. Perseverance is essential in this method of treatment and nearly normal conditions will be found within several months. It is much better for this treatment to be carried on in the hospital.

I always first perform full overcorrection of the deformity, because pain inflicted but once is better than a continuous annoying traction. Von Oettingen suggests applying a rubber bandage in the after-treatment, similar to the turns of the bandage around the foot and thigh and retaining the leg in a rectangular position. Fink applies for this purpose an apparatus equipped with elastic bands. This consists of a small piece which is used as a sole and to which the foot is attached. The elastic bands serve to correct the pronated position of the foot, drawing it

FIG. 53c.

The v. Oettingen-Fink bandage applied, foot in overcorrected position. Both feet successfully treated in three months.

towards a bandage applied towards the thigh. At our clinic the after-treatment consists in using small shoes made of celluloid and modeled from a cast taken of the feet in a pronated position. These are equipped with a band around the heel in order to check and prevent its protrusion. This method of applying the paste bandage is available only in the newborn and in such cases where favorable environments and intelligent nursing can be ensured. In older cases the resistance is so marked that the encircling bandage is ineffective, either in reducing the foot or in case of successful redressement, in retaining the foot in the proper position. The continuous flexion of the knee in older children produces discomfort which they try to overcome by using their lower extremities in a more energetic manner. The moulding redressement of Lorenz is the most suitable treatment for these cases. This consists in correcting the position and holding it by a plaster-of-Paris bandage. The moulding redresse-

ment is performed as in the newborn, but it consumes more time and strength, but it should not be abandoned until all obstacles are overcome. If the shortened plantar fascia presents much difficulty an incision should be made with a tenotome. A total dorsal flexion can be procured by a tenotomy. Two incisions are made with a tenotome, one on the median, the other on the lateral side in the tendo Achillis about two centimetres apart and cutting about half through the tendon. The longitudinal fibres are separated by manual pressure and the tendon is thus elongated without being entirely divided. Total redressement of the club-foot should always precede the tenotomy, as otherwise all resistance would be lacking when an attempt at redressement is made. The plaster-of-Paris bandage is applied with the foot in an overcorrected position, and then cut open along the instep, after hardening, in order to prevent pressure sores. The first bandage remains in position from three to four weeks. A second, and in difficult cases a third, bandage is applied until the deformity is entirely overcome (Figs. 51b, 55b).

The **after-treatment** consists in wearing shoes with the outer side of the soles raised. Celluloid plates with an elevation of at least $1\frac{1}{2}$ cm. can be worn inside of the shoe to which a splint is attached which serves to pronate the foot when the shoe is laced. In order to prevent the heel slipping, I use an appliance around the heel consisting of four straps which pass through four holes in the shoe near the heel and fasten around the ankle (see Fracture of femur).

Elastic bands are applied from the side of the shoe backwards and upwards to the opposite hip in cases of continued inward rotation of the hip. A splint apparatus could also be used and adjusted so as to bring about forcibly an outward rotation with the aid of a pelvic truss.

I never made use of mechanical appliances such as the osteoclasts of Lorenz, Schulze, or Thomas to correct these deformities, because I believe that it is possible to treat successfully any degree of club-foot in children without such procedure. The bloodless method of redressement, including tenotomy and fasciotomy, has always proved entirely satisfactory to me and the severer operations are unnecessary in children.

If for any reason early treatment is impossible I postpone the plaster-of-Paris treatment until after the sixth month. This is in conformity with the views of other authors, as it enables the child to walk on its feet immediately after the treatment is finished, so that the weight of the body assists in further correcting the deformity. When the correction is made at an earlier period a prolonged after-treatment is necessary, which in most cases cannot be carried out.

The treatment may be discontinued when the child is able to walk on the sole of the foot with the toes everted and actively to pronate and dorsi-flex the foot.

Relapses occur especially in the out-patient department on account of the dependence of such cases on external conditions and influences. Irregularity in applying the treatment and careless nursing inevitably cause relapses. It is therefore necessary to keep patients under observation at least once every two years, and perform subsequent operations, if occasion arises, before the deformity grows too old.

Fig. 54a.

Fig. 54b.

Fig. 54a.—Congenital club-foot (left leg). Baby twelve months old. The child walks on the outer border of the foot. The calves differ distinctly in form and shape.

Fig. 54b.—The same case after treatment with moulding replacement and three overcorrecting plaster-of-Paris bandages. (Duration of treatment six months.)

The fixation of so-called "rebellious" club-feet, which easily incline to relapses, is best accomplished by performing a tenoplastic operation. This consists in shortening the pronating muscles and making a periosteal transplantation of the insertion of the tibialis anticus muscle on the external border of the foot.

Among the many operations performed to correct this deformity Phelps's division of the soft tissues and Codivilla's combination of division of soft tissue and tendon transplantation may be mentioned. There are a number of bone operations which change the position of the

foot by osteotomy or removing some bony tissue at the outer border of the foot (enucleation, resection, wedge incision).

The **treatment of acquired club-foot** depends on the condition which brought about the deformity. The removal of cicatrical tissue by means of skin grafting and the reinstatement of active muscular contractions in paralysis may be employed. The latter can be accomplished by resuscitating the paralyzed muscle by nerve transplantation, or by transplanting the muscular insertion so as to give the desired direction of motion.

FIG. 55a.

FIG. 55b.

FIG. 55a —Bilateral congenital club-foot. Boy eleven years old. The child walks to a slight degree on the dorsum of the foot, using the legs like a pair of stilts. The muscles of the legs are atrophic. Four bandages, each of six weeks' duration, brought about an absolute change of position.
FIG. 55b.— Case in Fig. 55a with bandage applied. Overcorrecting plaster-of-Paris bandages are applied after successful completion of the moulding replacement and Achillo-tenotomy.

The treatment with apparatus should be confined solely to inoperable cases or used as an aid in the after-treatment. It consists in the application of hollow splint braces to support the foot in the corrected position and the use of elastic bands to check certain motions and to replace lost muscular power and activity.

F. RARE CONGENITAL DEFORMITIES OF THE FOOT

Congenital talipes equinus is occasionally met with, and differs from the one produced by a congenital spastic contraction of the gastrocnemius muscle (congenital cerebral palsy, Little).

Tenotomy of the tendo Achillis and subsequent plaster-of-Paris bandage for two or three weeks will correct the deformity.

Congenital flat-foot is sometimes found in combination with club-foot, but there is a tendency to a pes valgus deformity in a certain percentage of newborn infants. A marked flat-foot deformity, however, is not of frequent occurrence. The dorsum of the foot during the embryonic stage is pressed against the leg and retained in that position. Postfetal marks are left as evidence of this position. The feet of the newborn persist in this attitude of rest for a long time (Fig. 56).

The foot is pronated, dorsi-flexed and abducted at Chopart's joint. This is the exact counterpart to congenital club-foot. The sole is flat

FIG. 56.

Congenital flat-foot and club-foot. Held in the same position as presumably maintained in the uterus. The convex bulging of the sole of the flat-foot distinctly visible.

and in some cases convex, and the contours of the bones of the foot are visible under the skin of the sole.

The shortened peroneal, dorsal, and flexor muscles prevent a correction of this deformity. Correction is much easier than in club-feet and relapses are less liable to result, although a number of cases which make their appearance later in life must be traced back to a congenital disposition.

The treatment consists in applying paste and plaster-of-Paris bandages and braces similar to the treatment of club-feet.

Congenital talipes calcaneus also belongs to this category both as regards treatment and etiology. It is generally combined with a valgus component and in rare cases the foot is totally dorsi-flexed. Other deformities of the foot and toes are identical with those of the hands and fingers and need only be mentioned here.

SECTION II

DISTURBANCES IN POSTFETAL DEVELOPMENT

PATHOLOGY OF THE DISORDERS OF GROWTH

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DISORDERS of growth affect chiefly the bony skeleton and the muscles which support and propel the body. Several factors, biological as well as pathological, contribute to these changes. The bony skeleton which was originally planned to assume the position of a quadruped had to overcome many obstacles before it changed and adapted itself to the new surroundings. Some of these difficulties we have already mentioned in the discussion of congenital dislocation of the hip, and these manifest themselves at that period of life when the body commences to rise from the horizontal position.

The vertebral column, pelvis, and lower extremities are especially affected by the weight. This being a critical stage in the development of both the soft tissues and bony structures, disturbances in their future growth increase so much the more if the building material undergoes pathological changes.

Rachitis should be mentioned as one of the chief causes of disturbance at this period. In this disease the building material is changed into softer tissue and the solidity and resistive power of the bony skeleton are impaired by a pathological process, the result being that the bones become curved following the direction of the weight-bearing or of muscular action.

On the other hand, the formation of new bone tissue appears interrupted, the epiphyses are thickened and the longitudinal growth is delayed and distorted. The deformity of the bones combined with a diseased and flattened condition of the joints and ligaments, and also with marked atrophy of the muscular tissue, produces the typical picture of rachitis. This disease, starting in early infancy, continues through the first years of life and is a constant menace to growth and further development. Traces are manifest in later years of childhood, and at puberty it appears as the so-called *rachitis tarda* at a time when the body consumes a vast amount of energy as it is undergoing revolutionary changes. This decreases the resistive power of the body against

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disease at a time when the child's life and surroundings demand it in a much higher degree.

All deformities which are observed during the first and second childhood result from a combination of these factors. They pertain chiefly to the bones of the trunk and of the apparatus of locomotion.

A. CURVATURES OF THE SPINE

BY

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FORMATION AND FLEXIBILITY OF THE NORMAL SPINE

The vertebral column of the fœtus generally forms one single curvature, the convexity of which is directed backward (Fig. 57). The child retains this position more or less after birth during the first few months of life. If the child is kept in a recumbent position or on a hard bed a slight flattening of the kyphosis may take place, while the use of the feather mattress will increase the kyphotic curvature which the embryonic vertebral column presents. An important change takes place in the vertebral column when a child at the age of three or four months begins to lift the head and turn it backwards. The dorsolumbar region of the spine still retains the existing kyphotic curvature, but the cervical part now changes from the original kyphotic condition into the opposite curvature—a lordosis with the convexity forward (Fig. 58).

A second change in the shape of the spine takes place at the end of the first year when the child begins to stand on its feet and attempts to walk. The muscles of the back, which hitherto have been little used, are now set in motion. They arise from the sacrum and are inserted at the lower portion of the dorsal region of the spine. In contracting they force the kyphotic curvature, which until then was formed by the lumbar region of the spine, gradually forward and finally transform it into a marked lordosis. As a result of this total change the vertebral column, which was originally of a total kyphotic shape, now presents an anterior lordotic curvature in the upper cervico-dorsal region, the original posterior kyphosis in the dorsal region, and the anterior lordotic projection in the lumbar region. Thus the fundamental "long S shape" is attained which the spine presents in adults of erect and faultless carriage (Fig. 59).

FIG. 57.
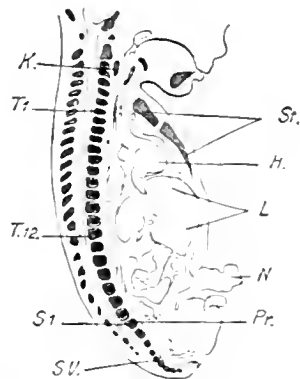
Vertebral column of an embryo
(after Dissen).

A continuous and harmonious coöperation of numerous muscles is essential to retain the spine in a normal position. The posterior muscles located on both sides of the spine tend to increase the lordosis, while the anteriorly located abdominal muscles tend to augment the kyphosis. The normal posture is dependent not alone on the form of the spine, but it is subject also to the position of the pelvis. The connection of the pelvis with the spine by means of the sacro-iliac articulation is rather rigid. For this reason the attitude of the spine is intimately associated with that of the pelvis. The pelvic motions are based on an axis connecting both hips. In a recumbent position the

FIG. 59.

FIG. 58.

FIG. 58.—Normal infant, four months old. Lumbar and dorsal region of the spine present the original kyphosis, the cervical part has already formed a lordotic curvature.
FIG. 59.—The normal attitude of an adult (after Staffel).
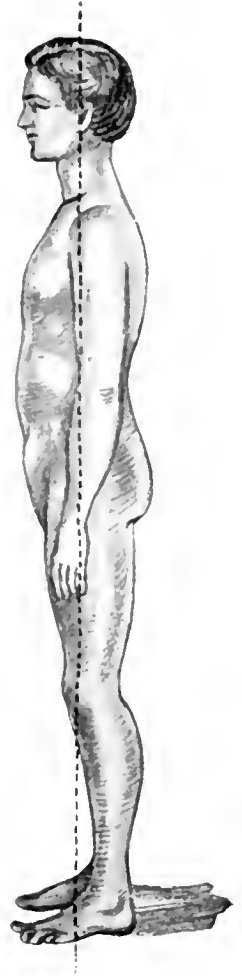
pelvis is at rest, the thighs alone being able to make certain motions which are termed flexion and extension and result from the action of the flexor and the extensor muscles of the hip.

In the erect attitude, with the legs fixed, pelvic motions are made by like muscular action. When the flexor muscles become active the

FIG. 60.
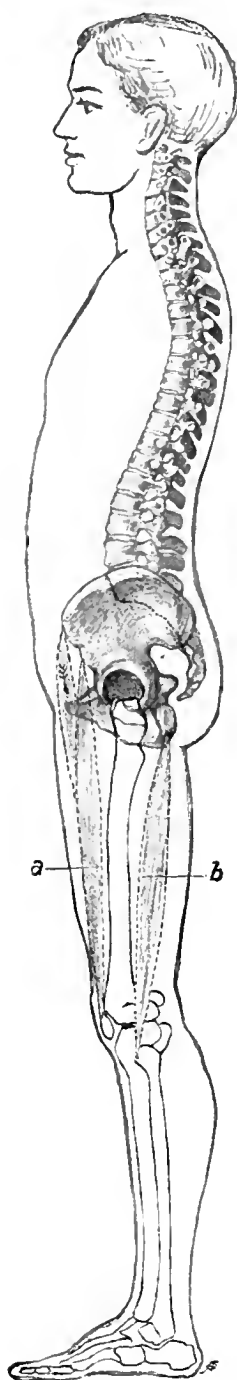
Schematic section to demonstrate motion of pelvis and spine with the aid of the extending (a) and flexing (b) hip muscles.

anterior part of the pelvis is tilted downwards and the plane through the superior pelvic entrance becomes nearly vertical. This pelvic position is called increased inclination of the pelvis. The reverse takes place when the extensor muscles of the hip are brought into action. The posterior part of the pelvis is then tilted downwards and the superior pelvic strait appears more or less horizontal. This attitude is termed decreased inclination of the pelvis (Fig. 60).

It is evident that the attitude of the pelvis exerts a marked influence on the carriage of the

FIG. 61a.   61d   61e.   61b   61c.
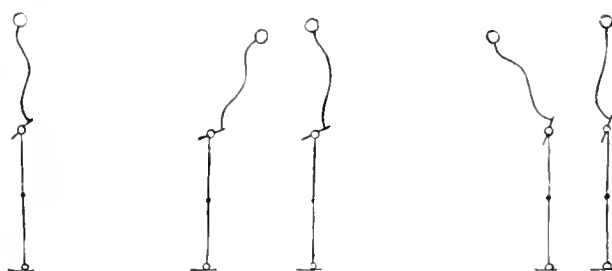
Schematic picture to demonstrate the influence of the pelvic attitude on the shape of the spine. Fig. 61a, normal attitude; Figs. 61b and 61c, attitude with pelvis markedly inclined (lordosis more pronounced); Figs. 61d and 61e, attitude with pelvis less inclined (kyphosis of spine more pronounced).

vertebral column as well as on the position of the trunk. In case of an inclined pelvis, i.e., when the superior pelvic strait is more vertical, the trunk would fall forward were it not for the action of the lumbar region of the spine, which, owing to a marked lordosis, bends the spine backward (Figs. 61a, 61b, 61c). Decreased inclination of the pelvis has the opposite effect. In this case the falling of the trunk backward is prevented by a marked posterior kyphotic curvature of the lumbar region of the spine forcing the upper part of the spine forward (Figs. 61d, 61e). In normal attitudes, according to examinations made by Henggeler and Schulthess, a line connecting the promontory and upper border of the symphysis forms an angle of fifty degrees with a horizontal plane. To get prompt information as to the

normal appearance of the spine and pelvis in a living person, Schulthess suggests that a vertical line be drawn from the cervical region down to the lowest point of the sacrum. Such a line in a normal case must either slightly touch the dorsal curvature or pass very near it. Besides the shape of the spine and the inclination of the pelvis the other components which contribute to a normal attitude are of minor importance. It is evident that the legs are extended at the hip- and knee-joints, being kept in a position such as to enable a vertical line running upward

Fig. 62a.   Fig. 62b

Correct attitude of the shoulders.   Faulty, careless attitude of shoulders.

from Chopart's joint to strike the hip and the ear. Finally, in order to maintain a normal attitude it is necessary to hold the shoulders backward in a position half way between high and low elevation (Figs. 62a, 62b.)

THE POSTURAL DEFORMITIES OF THE SPINE

I. KYPHOSIS

The formation of kyphosis of the spine is explained by the assumption of an habitual attitude characterized by an increased posterior curvature of the spine. The German term for this postural anomaly is "round back" (runde Rücken). Kyphosis may involve the entire spinal column from the first cervical vertebra down to the sacrum. Such curvature of the spine is called total kyphosis. This is an exceptionally rare occurrence. I found it only twice in children as a congenital deformity; it was probably the result of deficient amniotic fluid in intrauterine life where the kyphotic position was retained for a long period and, as it were, grew stiff and rigid in its attitude. The deformities of the spine which present pathological kyphosis in the dorsolumbar region

are much more frequent while the cervical part shows the physiological lordosis. This form of kyphosis is most frequently observed during the first and second year in rachitic children (Fig. 63).

Rachitic Kyphosis.—A characteristic symptom of this form of round back is the marked posterior projection of the lumbar portion of the spine. Assuming the sitting posture in bed at too early a period is the main reason in rachitic children for this marked kyphosis of the lumbar region. Extension of the legs at the knee-joint and rectangular flexion

Fig. 63.

Rachitic kyphosis.

in the hip force the muscles to contract and to rotate the pelvis backward in such manner as to decrease the inclination of the sacrum and to change the forward position into a more posterior direction. The lumbar region following the excursion of the sacrum necessarily forms an increased kyphosis. Carrying children on the arms aggravates the disposition to kyphosis. Finally, faulty arrangement of the bed (too many pillows and a soft feather mattress instead of a hard even mattress) may result in an increased kyphosis of the soft rachitic vertebral column.

This rachitic kyphosis becomes especially damaging when children fail to stand and walk at the proper time. At that time the factor is suppressed which, as described above, has the greatest influence on the development of the physiological lumbar lordosis. This results in

rigidity of the lumbar region of the spine in the form of an habitual kyphotic curvature.

Very little attention is paid to a rachitic kyphosis. Although the marked degree of kyphosis which is found in children during the first and second years disappears later to a great extent, yet much trouble has often resulted from these kyphoses of rachitic origin.

Spitzy observed that rachitic kyphoses very often develop later into scolioses. I have noticed that children with rachitic kyphoses acquired during infancy have developed pronounced round shoulders

Fig. 64.
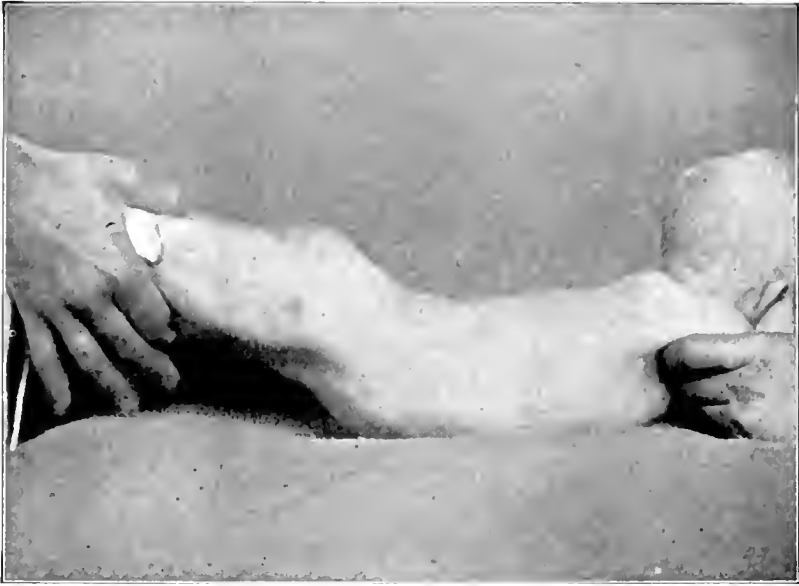
Vertebral column without any rigidity.

in their second decade. Similar observations have also been made by other authors.

One must bear in mind the later results of a rachitic kyphosis to realize fully the importance of early treatment.

Diagnosis.—Inclination to kyphotic posture is best observed in infants while in the sitting position. The spinal column of a normal child of six months when seated with hip and knee-joints in rectangular flexion, assumes the position as reproduced in Fig. 58. Any marked posterior projection of the lumbar portion of the spine must be looked upon as an inclination to kyphosis and treated accordingly. An incipient rigidity can more readily be detected when the baby lies on its stomach. Upon grasping the baby by the legs and raising it a little the spinal column, if normal, assumes the most marked lordotic shape possible, and presents a picture as reproduced in Fig. 64.

The rigid rachitic kyphosis, however, presents a posterior convex curvature in the dorsolumbar portion of the spine (Fig. 65).

Naturally, **treatment** in the first place aims at remedying the general rachitic affection. The steps to prevent kyphosis have already been mentioned in the etiology. Rachitic children should sleep on an even, hard mattress and should not be carried on one arm or sit up in their carriages with the knees extended.

In the event of a child coming under medical observation at a time when kyphosis is developing, the main point is to insist on the child assuming a position such as to produce a lordosis of the spine. In the former class, the suspension method recommended by Rauchfuss is best

Fig. 65.
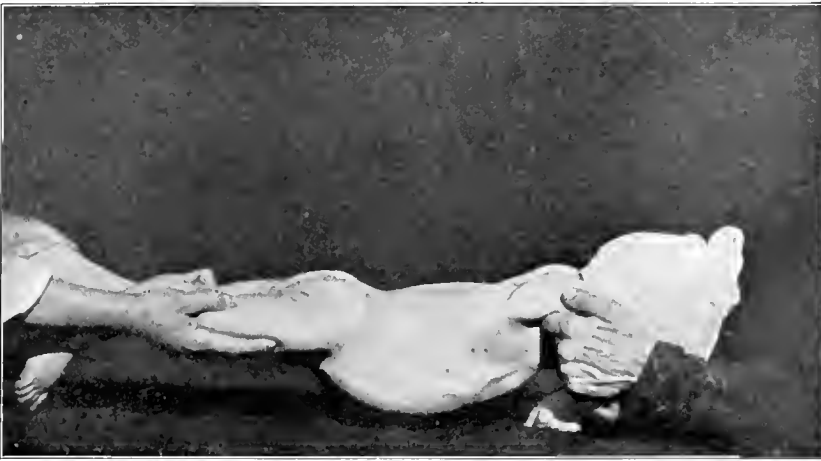
Rachitic spine with kyphotic rigidity of the dorsolumbar portion.

applied, or a cushion, 5–10 cm. thick and 30 cm. long, filled with cotton or horsehair is placed between the mattress and back in the waist line region so as to induce lordosis of the lumbar region of the spine, which is particularly endangered in rachitis.

The reclining orthopædic beds, recommended by Lorenz for spondylitis, but also admirably suited to rachitic kyphosis, give, however, much better results than such makeshifts, because of the simplicity of construction. The technic adopted at our hospital is as follows:

The infant, clad entirely in a bandage of webbing, lies on the abdomen. Both thighs are placed on a cushion 20 cm. high and fastened there with a strap. The child's trunk rests with its sternal portion on a second cushion likewise 20 cm. high (Fig. 66). The aim is to obtain the most pronounced lordosis of the spine possible. A large piece of common padding (1–2 cm. thick) is cut out so as to cover the posterior and lateral surfaces of the head, neck, trunk, and pelvis. This layer of padding is

fastened to the chiid with gauze bandages, all folds and wrinkles being carefully eliminated. A plaster-of-Paris bandage is now applied. Four to six bandages are sufficient to make a bed for an infant.

In general, transverse and longitudinal turns are applied over the body of the child as far as it is covered by the padding. Finally, several turns are carried over the front part of the patient's trunk so as to secure a snug fit of the plaster cast.

To strengthen the bandages, ten small wooden splints applied in transverse and longitudinal directions alternately may be added.

After the bandage hardens, the child is placed in a recumbent position. The webbing and plaster bandage are cut open along the abdomen and the child taken carefully out of the cast. The borders of the plaster bed are now straightened. Provision must be made for free and unlimited use of the arms and for a space around the anus to permit defecation

Fig 66.
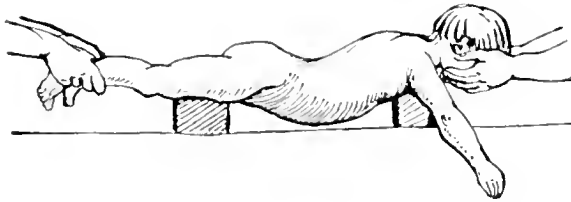
Position of child for application of plaster bed.

(Fig. 68). The overlapping padding is pulled outward over the borders of the plaster bed so as to have the edges padded all around. Padding and webbing are fastened to the plaster bandage with a couple of stitches to render later displacement impossible. The bed is then hardened by a heater. In twenty-four hours two to four bandages are added to the outside of the bed, saturated with isinglass, thereby materially increasing its durability.

At first, such a bed is made use of for a couple of hours only. Later on, when the child has become accustomed to it, it is applied day and night.

At intervals of from one to two weeks the lordosis-producing effect can be increased by placing small cotton pads under the lumbar portion of the spine, gradually exchanging them for larger.

These beds may also be made of celluloid and steel wire. Such beds are much lighter than plaster-of-Paris beds and the child, with its bed, can therefore be carried around by the nurse much more easily. They are also waterproof and therefore much cleaner than the plaster beds. Because of the special experience necessary to make and fit them well, an extensive description of the orthopædic technic may be omitted.

Placing the kyphotic child in a position which results in a very pronounced lordosis of the spine, as described above, is the first and easiest step in the treatment. It is much more difficult to strengthen the already over-extended and therefore weakened muscles of the back. Massage of these muscles (twice daily for five minutes, rubbing and stroking alternately) may be performed at any age, but gymnastic exercises cannot be carried out in infants. As a substitute the children can be placed on the abdomen several times a day for a quarter of an hour, and by holding toys above the head may be induced to perform motions which tend to increase the lordotic attitude. As soon as the children grow older, starting with the second year, Epstein's easy chair may be successfully employed to strengthen the muscles of the back. Spitzy was the first to call attention to the excellent effect of crawling motions for strengthening the muscles of the back.

The "Round Shoulders" of School Children

Later on in childhood, especially during the school period, a type of kyphosis makes its appearance which, although embracing the dorsal and lumbar portions of the spine as in rachitic kyphosis, exhibits the most marked projection a little higher up, usually in the centre of the dorsal portion of the spine and not in the lumbar portion. This attitude, of which Fig. 67 is an excellent reproduction, is the most common of all kyphoses.

Most children whose bad carriage elicits steady complaints from the parents exhibit this postural anomaly. The causes of the deformity may be traced back in the main to the fact that children try to hold and fix their trunks with as little muscular action as possible.

To hold the spine in such a position as to conform with the physiological curvature, a continuous action of the erectores spinæ as well as the flexor and extensor muscles of the hip is essential. However, the constant muscular activity becoming tiresome in a short time, the children seek to fix the spine by positive contraction of muscles and checking of ligaments. This is done by the dorsal and lumbar portions of the spine assuming a totally kyphotic curvature. The ligaments inserted along the posterior aspect of the spine, the ribs and spinal processes, act in opposition while the vertebral bodies are pressed together at the front of the spine, thus producing a rigidity of the otherwise flexible structure.

Aside from these vertebral changes, other variations of normal posture are often found in these cases and may be briefly mentioned.

In nearly all dorsolumbar kyphoses a markedly decreased inclination of the pelvis is noticeable.

This attitude, as in the kyphotic fixation of the spine, is likewise caused by passive contraction of ligaments, which acts as a substitute for the tiring muscles.
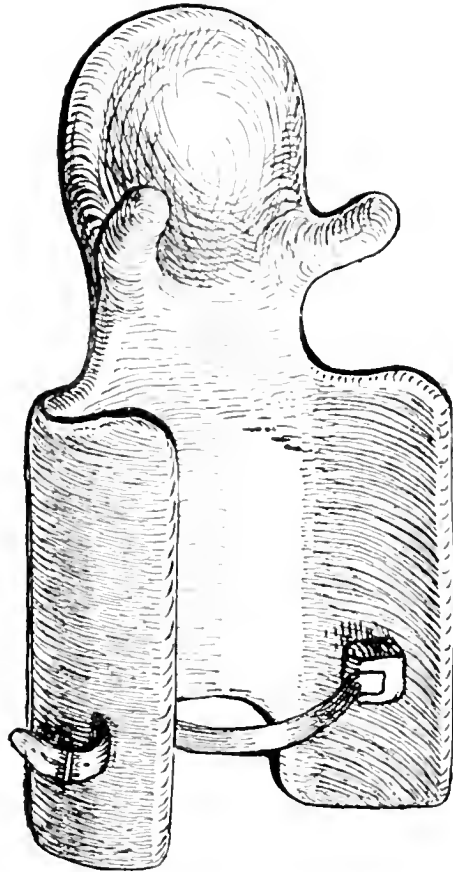
Children with weak or inactive muscles and "round backs" avoid all straining motions of the flexor and extensor muscles of the hip, which are needed in maintaining the normal posture of the pelvis. Instead they keep lowering the posterior part of the pelvis until the muscles of the hip which are

Fig. 67.
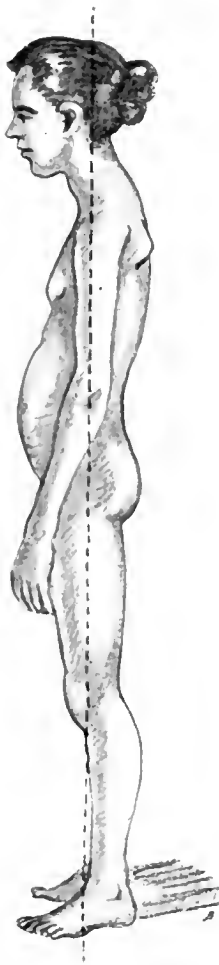
Round back (after Staffel).

Fig. 68.

The plaster bed for kyphoses.

inserted along the anterior border of the pelvis (tensor fasciæ, sartorius, iliopsoas) become quite tense as well as the anterior ligaments of the capsule of the hip-joint.

Finally, these children with round backs let their shoulders drop forward and downward in order to eliminate as much as possible the irksome activity of the shoulder muscles (elevation and backward traction).

The pathological changes in round backs of school children consist principally in an over-extension of the ligaments and muscles situated on the posterior aspect. In case of a persistent kyphotic posture the soft tissues become shortened in front and the intercartilaginous surfaces, as well as the osseous vertebræ, undergo changes to the extent that the anterior parts become thinner and the posterior parts grow thicker, resulting finally in a decreased flexibility of the spine and producing a rigidity.

Assuming that muscular inactivity is the most important and decisive

Fig. 69b.

Fig. 69a.

Bending forward of trunk.

Bending backward of trunk.

factor in the causation of round shoulders, treatment is easily mapped out.

Our aim should be to methodically strengthen the muscles of the shoulders, back, and pelvis by appropriate gymnastic exercises.

The following simple exercises are recommended:

1. *Bending the Trunk Forward and Backward.*—The child assumes an erect position with the hands clasped together across the back. The body is bent forward, then the arms are projected backward with extended elbows and the shoulders are drawn together. Finally, with

shoulders and arms held in above mentioned position, the trunk is gradually straightened, forcing the spine into a lordotic curve (Figs. 69a, 69b).

2. *Breathing Exercises.*—The child assumes a position as reproduced in Fig. 70a. During a forced expiration the arms are brought forward until they are parallel to each other (Fig. 70b). Then while the

FIG. 70a.

FIG. 70b.

Breathing exercise (inspiration).
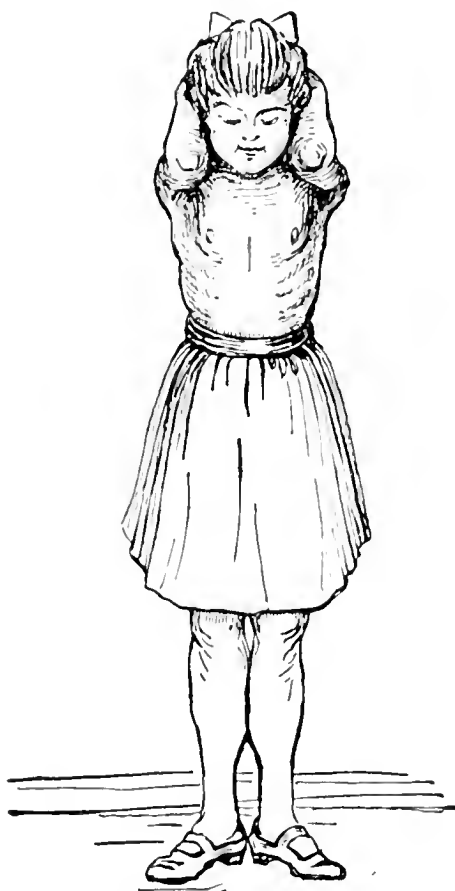
Breathing exercise (expiration).

arms are carried as far backward as possible, a deep breath is taken (Fig. 70a), and at the same time the child raises his body by standing on his toes.

3. *Walking Exercises.*—To get children accustomed to an erect posture when walking all exercises must be performed in the attitude reproduced in Fig. 70a.

The amount of work performed by the muscles is best estimated with apparatus recording the resisting power. A simple model which I

Fig. 71b.
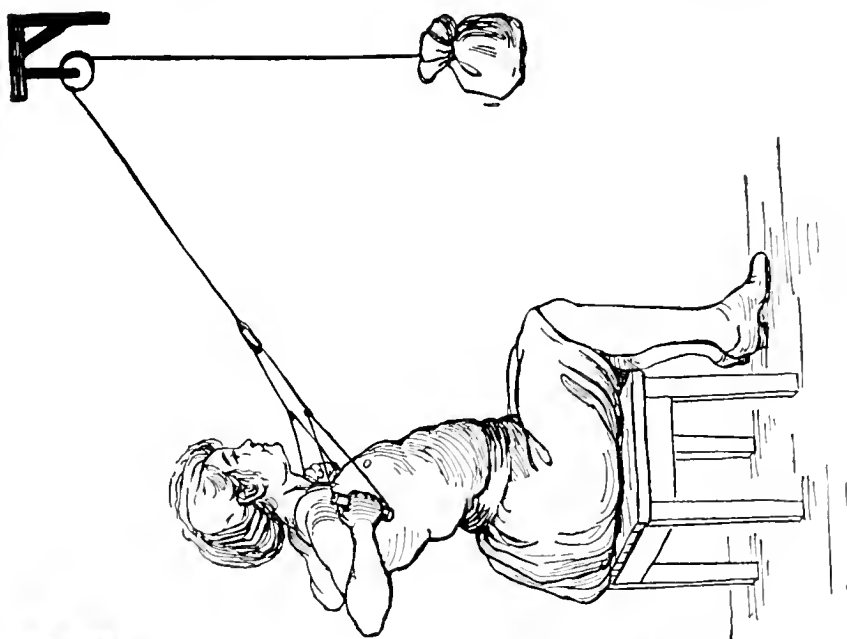
Hand traction apparatus with weight.

Fig. 71a.
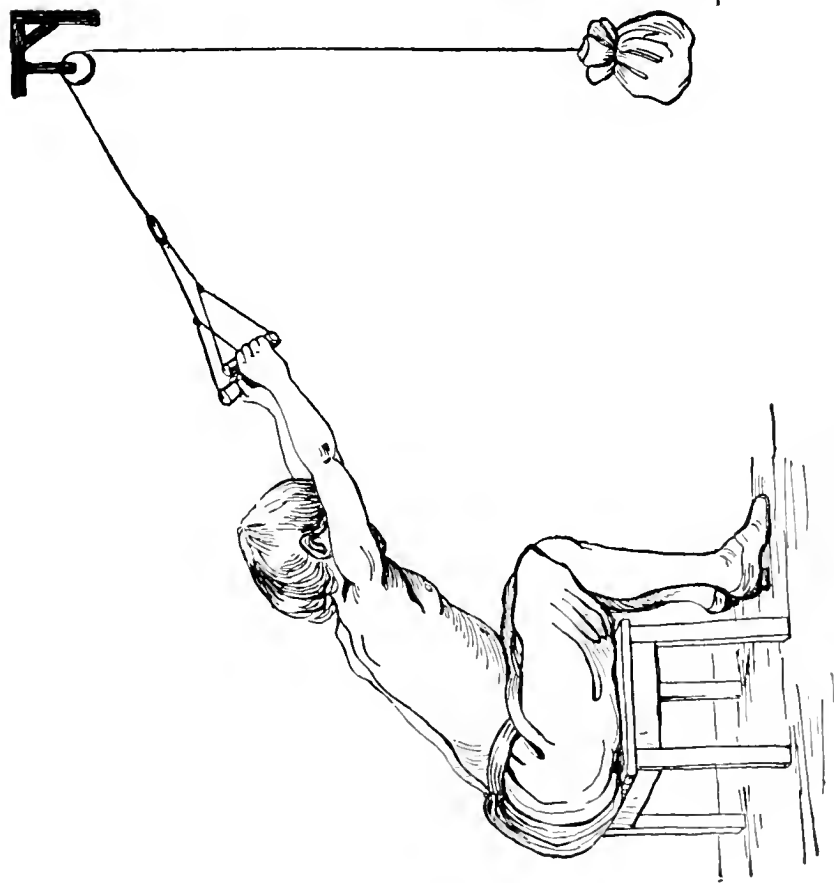
Hand traction apparatus with weight.

am accustomed to use is reproduced in Fig. 71. It consists mainly of a
rope running over a pulley having at one end two handles and at the
other end a weight. The child is seated at a distance of about three
feet from the apparatus and assumes an inclined, relaxed posture as
reproduced in Fig. 71a. At this stage the weight rests on the floor.
The aim of the exercises is to have the child lean far backward, assume

Fig. 72.
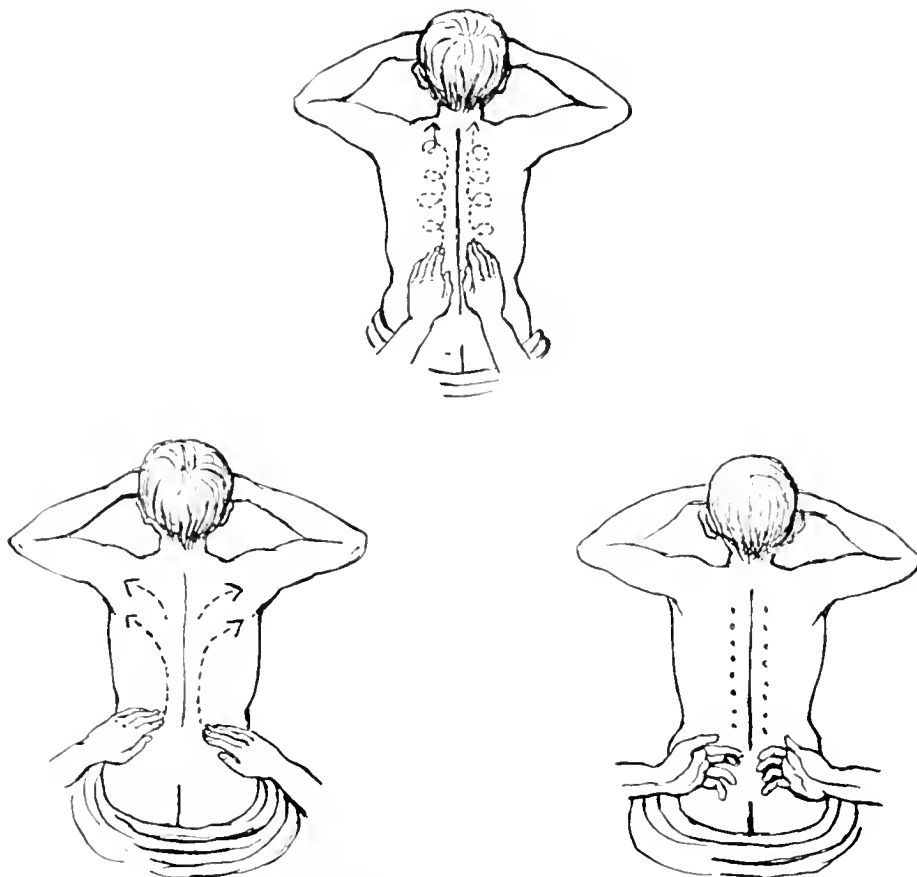
Massage of the muscles of the back.

a rigid military attitude and simultaneously lift the weight (Fig. 71b),
while the elbows are carried upward and backward as far as possible.
The apices of the lungs are relieved of the shoulder weight and the
inrushing air circulates more freely through the upper pulmonary regions.
Both positions as reproduced in Figs. 71a, 71b, must be maintained for
at least three seconds to insure an interval between the two parts of the
exercise. The weight must be small at first, figuring one-half pound for
each year. A child six years old should commence with a three-pound

weight. One-half pound may be added every two weeks. The exercise is performed daily once or twice for a quarter of an hour. After the exercises an intermission is allowed the child for rest.

It is manifest that the more complicated apparatus invented by Schulthess, Zander, and others, used in medico-mechanical institutions, may also be employed with very good results.

Aside from these methodical muscular exercises, children with round shoulders should play out in the fresh air daily, to overcome as far as possible the disadvantages which accompany school attendance.

In order to increase nutrition, daily massage of the muscles of the back is recommended as shown in Fig. 72. In case of inclination to rigidity special exercises must be added to stretch the shortened parts located on the anterior aspect of the spine. Hanging from Glisson's suspension apparatus, or from rings, or reclining over a cross-bar may be tried. These active and passive exercises must be kept up daily for from one-half to one hour, according to the seriousness of the case.

In children with round shoulders especial attention must be paid to the construction of seats. If the seat is without an adequate back children will surely assume a kyphotic posture.

Because most of the desks and chairs do not conform to medical demands and besides are quite expensive,

FIG. 73.

Reclining position over the cross-bar (after Lorenz).

it may be well to describe how to manufacture a cheap and good desk chair.

A common wooden or cane-bottomed chair with a somewhat inclined back suffices. The height of the chair must correspond to the length of the legs (Figs. 74b, 74c). If the chair is too high an adequate footstool must be placed under the feet. The depth of the seat corresponds with the measurements taken from the posterior pelvic surface to the popliteal space (Figs. 74a, 74b). If the chair is too deep a thick cushion must be fastened to the back to allow the child to lean comfortably against it with the entire dorsal surface. Under all circumstances a small pillow 5–8 cm. thick should be fastened to the chair in the line of the waist to encourage the child to assume a lordotic curve of the spine (Fig. 74a, d). To force a child to lean back against the chair shoulder bands may be
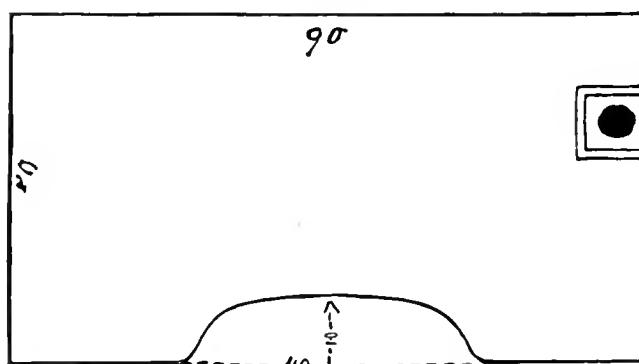
employed (Fig. 74a). The height of the top of the desk should correspond with the xiphoid process. Round and oval tops are detrimental. To obtain a good support for the elbows an excavation may be made in
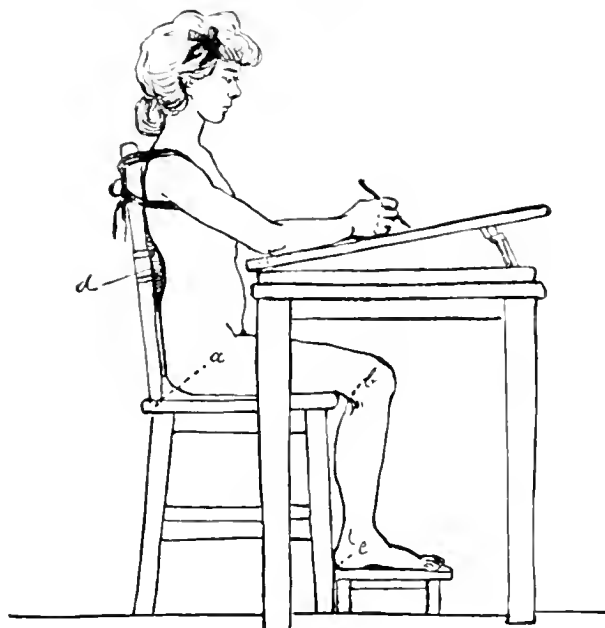
Desk and chair.

Fig. 74b.

Top of the table.

the table as reproduced in Fig. 74b. Chair and child must be so near the desk that a distance of not more than 5 cm. separates the chest and the edge of the desk.

In case the child is accustomed to holding his head forward, I fasten to the desk a forehead support such as is used by oculists, consisting principally of an iron rod bent thus: ⌊___⌋.

Finally, the employment of braces to straighten the body must be discussed. We recommend making as little use of them as possible, because all braces as long as they are in use exclude muscular activity and therefore weaken the muscles. We use braces only during school time. We know of no model among the large assortment of braces advertised in newspapers which would not be objectionable in some respect. In smaller children we employ a brace modeled after a plaster-of-Paris cast which does not cover the chest and abdomen.

In older girls we fasten to the corset strong dorsal splints which are adapted to a marked lordosis of the spine and felt-padded bands are passed over the shoulders to pull them backward (Fig. 75).

FIG. 75.

Braces to straighten the body, attached to the corset.

II. LORDOSIS

Excessive lordosis of the spine is due chiefly to hip diseases (Fig. 76).

In marked flexor contraction in one hip-joint occurring after coxitis the patient, in order to place the diseased leg parallel to the sound one, is forced to rotate the pelvis in such a manner as to considerably tilt the anterior half downward. With this manœuvre the sacrum assumes a more or less horizontal position. The lumbar portions of the spine follow this motion. To prevent the trunk from falling forward the upper half of the spine must be bent backward while the lumbar portion assumes a marked lordotic form.

Lordosis in bilateral dislocation of the hip results from the location of the heads and shafts of the femurs behind the sockets. The front part of the pelvis becomes too heavy, sinks downward and forces the patient, for the sake of keeping his balance, to compensate with an extreme lordosis of the spine.

A third cause of excessive lordosis is paralysis of the dorsal muscles, as for example in dystrophy.

Finally, an excessive lordosis has also been observed in cases of spondylitis.

Treatment of these various kinds of lordosis must begin with the causative factors. With their remedy the lordosis, which has no tendency to rigidity, generally disappears of its own accord.

Fig. 76.

Lordosis of spine resulting from flexion contraction of hip.

III. SCOLIOSIS

Scoliosis is a permanent lateral deviation of the spine. It must be well differentiated from an uncertainty of attitude. It has often been observed in children under ten years that the spine forms a lateral curvature, because of inability to control their muscular action sufficiently to hold the still very flexible spine straight. Constant observation and repeated examinations

Fig. 77.

Convex total scoliosis to the left.

prove that the uncertainty of attitude is accompanied by a convex curvature of the spine to the right or to the left. In a true scoliosis the spine always presents a permanent curvature, and although the degree of curvature differs at times, being as a rule more pronounced during a period of fatigue, its character and localization remain the same.

Cases of scoliosis where the spine presents a single curvature are termed right or left convex total scoliosis (Fig. 77). Opinions differ

widely as to the frequency of this form of scoliosis. We have observed this form chiefly in children ranging from four to eight years. Later compensatory curvatures appear usually at the upper or lower end of the primary curvature. Schulthess also reports similar observations. According to his investigations total scolioses amount to 15 per cent.; according to our own material to about 10 per cent. If the scoliosis is confined to one portion of the spine it is termed, in accordance with its localization, lumbar, dorsal or cervical scoliosis; if the curvature embraces more than one division, a dorsolumbar or dorsocervical scoliosis.

As a rule there are one or two compensatory curvatures directed toward the opposite side, just above or below the region of the spine that is affected by the main curvature. The most frequent form of scoliosis belonging to this type is reproduced in Fig. 78.

It is evident that curvature of the spine changes also the lateral outlines of the trunk—the side of the trunk corresponding to the convexity projects while the opposite side recedes. Consequently the hip projects on the concave side and the layman terms the condition a high hip (Fig. 78). A change in the attitude of the shoulders generally accompanies the curvatures of the upper half of the spine. As a rule the shoulder corresponding to the convex side is held higher than the one on the concave side (high shoulder, Fig. 78).

To these changes must be added, in every case of scoliosis, deformities of the trunk which are produced by torsion.

FIG. 78.

Convex lumbar scoliosis to the left, convex dorsal scoliosis to the right, convex dorsocervical scoliosis to the left.

Every lateral curvature of the spine is accompanied simultaneously by a rotation of the bodies of the vertebræ. The vertebra generally rotates around its sagittal axis, the side corresponding to the convexity projecting backward. The rotation of the vertebræ is less noticeable in the small vertebral bodies but is conspicuous in the long ribs attached to the vertebræ. In scoliosis a projection of the ribs backward takes place always on the convex side while the concave side of the thorax is twisted forward.

Etiology.—The causes of scoliosis are of a very varied nature.

I. *Congenital Scoliosis.*—There are doubtless congenital scolioses produced either by constrained positions during the period of intrauterine life or caused by an asymmetrical arrangement of some of the vertebræ.

Böhm's interesting investigations have quite recently drawn attention to the latter type. An X-ray picture of such congenital scoliosis is reproduced in Fig. 79. To this type belong also Garré's congenital scolioses which are caused by a seventh cervical rib. It is quite certain

Fig. 79.
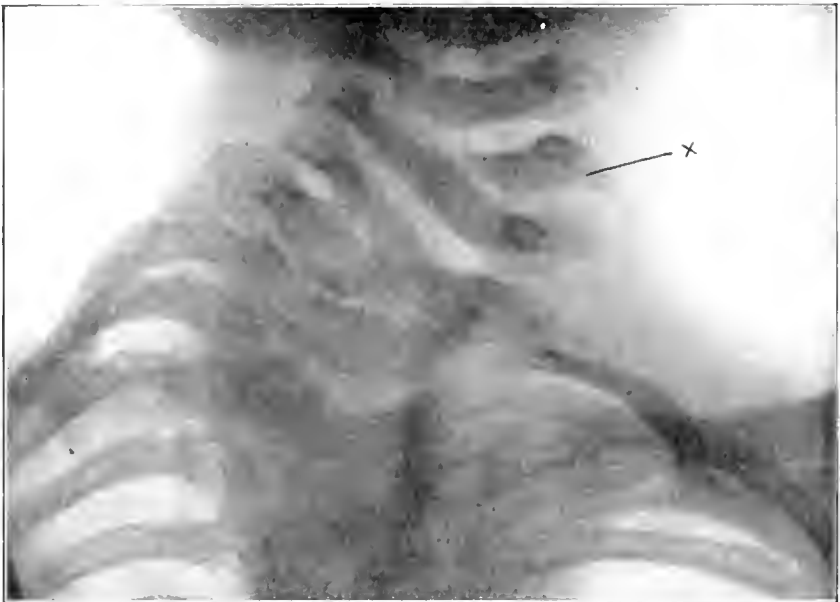
Congenital scoliosis caused by the deficiency of one-half of a vertebra.

that congenital scolioses are much more frequent than has been estimated heretofore. But Böhm's opinion — that most scolioses which develop in later life may be traced back to primary embryonic disturbances—appears not to be well founded.

II. *Rachitic Scoliosis.*—In rachitic children scoliosis is frequently evoked during the first year by clumsy carrying and handling (Fig. 80). Such scolioses have to be dealt with very carefully. They soon develop to a marked degree and often present a marked rigidity during the second and third years. Nearly all advanced cases of scoliosis, especially all presenting simultaneously a kyphosis of the spine, called kyphoscolioses, are caused by rachitic processes.

III. *Static Scoliosis.*—Inequality in the length of the legs causes a distortion of the pelvis and the spine. However, to hold the trunk

vertically above the pelvis the patient must distort the spine into a scoliotic curve.   A difference in the length of the legs is observed in congenital dislocation of the hip, in diseases of the hip-, knee- or ankle-joint, in paralyses, and in other marked deformities of the leg.   Differences of

Fig. 80.

Faulty position of a child favors scoliosis.

Fig. 81.

Development of a convex scoliosis to the left as a result of habitually lying on the left side.

from 1 to 3 cm. in the length of the legs occur without any apparent cause.   Until the eighteenth year such differences may disappear or at least become less.

IV. *Habit Scolioses.*—The exciting cause in the great majority of scolioses is the habitual assumption of a posture in which the spine, for

a longer period, takes on a lateral curvature. This attitude may be purely passive; for example, when a child sleeps during the night regularly on one side and uses a large pillow the spine always assumes the same lateral curve (Fig. 81). But the lateral curvature may likewise be produced by active muscular action. It happens in all unequal, unilateral exercise, *i.e.*, working as cabinet maker, playing the violin, playing lawn tennis or carrying school books on one side only (Fig. 82). When in pain, as from a furuncle, or pleurisy or rheumatism, patients are induced to bend the spine so as to form a lateral curvature in attempting to get relief. Faulty posture in writing may be looked upon as a combination of the active and passive factors inducing lateral curvature of the spine. That, fortunately, only a small number of these scolioses develop as a result of faulty attitude, we must attribute to a further fact which of itself causes a deformity of the spine. It has been surmised that rachitis even in the later school period softens the bones, making them pliable and yielding to faulty positions— terming the disease *rachitis tarda*— but the present material is not sufficient to warrant a definite opinion.

Fig. 82.

Development of a convex scoliosis to the left as a result of carrying school books on the right side.

One point, however, seems to be evident as a result of clinical experience, namely, that to the other causes an especial flexibility of muscles and ligaments and an abnormal softness of the bones must be added to transform an occasionally occurring lateral curvature of the spine into a true scoliotic deformity.

V. *Scolioses Resulting from Other Causes.*—Rachitis and habit are in nearly all cases the predisposing and exciting causes of scoliosis. A very few cases are based on other ailments. Occasionally pleurisy and empyema may produce scoliosis as a result of the accompanying contraction of the lungs. In such cases the convexity is directed toward the sound side (empyemic scoliosis). Finally, paralysis of one erector spinæ muscle now and then may be the cause of a spinal scoliosis. The convexity in such paralytic scoliosis is, as a rule, not directed toward the diseased side, as may be presumed, but generally turns toward the sound side. To overcome the deficient action of the paralyzed erector

spinæ muscle the patient bends the trunk toward the opposite side, the force of gravity and the support of the other sound erector spinæ holding it in balanced suspension over the pelvis.

Pathological Anatomy

The pathological anatomy of scoliosis has been most diligently studied by our most famous authors, Albert, Nicoladoni, Lorenz, Hoffa, Schulthess, and others, but we are still far from solving this very interesting as well as difficult problem.

It is manifest that in a scoliosis of short duration only trifling deviations from the normal anatomy of the spine are found, while very marked scolioses of long duration produce pronounced changes in form and func-

Fig. 83.
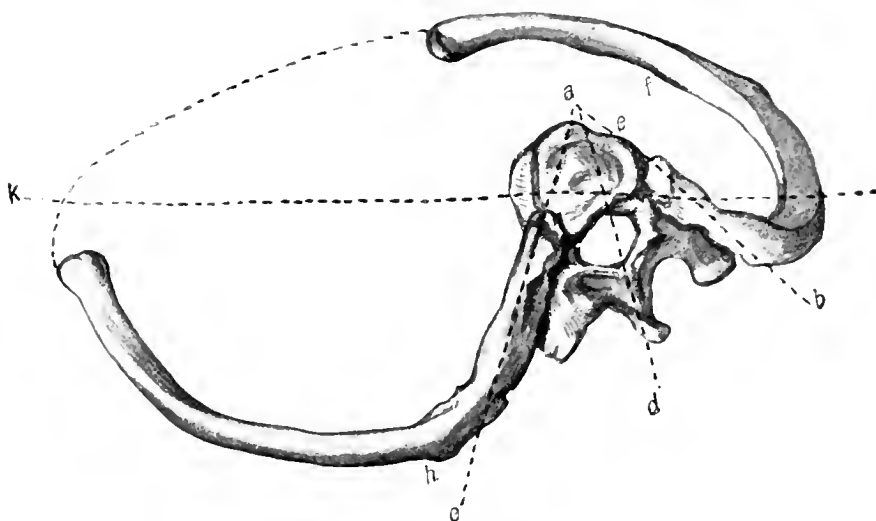
The ribs of a case of scoliosis with a convexity to the right (after Lorenz).

tion of the spine. In general, the following rule may be applied to the soft tissues and osseous vertebræ: every part located on the concave side is shortened; every part located on the convex side is lengthened. Details may be here considered only as they pertain to practical clinical conditions. Chief consideration must be given to the form of the thorax in a case of scoliosis. Vertebræ and ribs are pressed together on the concave side, whereas on the convex side the ribs spread apart, thus enlarging the intervetebral spaces. At the same time the curvature of the ribs undergoes a change. On the convexed side the ribs are deflected toward the front in the region of the posterior angle, thus producing the characteristic form of the posterior costal angle. Toward the front they become fairly straight. Just the opposite condition prevails on the con-

cave side of the trunk. The ribs are exceptionally straight posteriorly and display a somewhat pronounced deflection near the sternum at the articulation of bone and cartilage, forming the so-called anterior costal hump (Fig. 83). As a result the space for the development of the lung on the convex side is materially diminished. Therefore, in marked scolioses the principal work in breathing is performed by the lung which is located on the concave side. The diminished exchange of air favors apical tuberculous infiltration in scoliotic patients. Mosse found among one hundred children fifty-three cases of infiltration of the apex. In dorso-scolioses the apical affection was found mostly on the convex side. The heart is often found to be hypertrophied on account of strain. Displacements have also been observed in marked cases of scolioses. The aorta follows the scoliotic curvature, while the œsophagus is displaced, or it may be kinked, only in marked deformities, thus offering an obstacle to passing a stomach-tube. Intercostal neuralgias, finally, are of great practical interest. They occur mostly on the concave side and are excited by the pressure on the nerves exerted by the compressed ribs. Neuralgias also appear on the convex side.

The Frequency of Scoliosis

Scoliosis is the most frequent deformity, as 25 to 30 per cent. of all school children are scoliotic. In schools for boys the percentage ratio is not quite so high, but most of the marked cases are found among boys. The reason for this condition is, in all probability, that in boys little attention is paid to an erect posture and the resulting scoliosis remains neglected.

Prognosis.—The fate of a scoliotic child depends, as a rule, on the time treatment can be instituted. Spontaneous recovery from a true case of scoliosis must not be expected. Many laymen as well as physicians are still of the opinion that scolioses are outgrown in the course of years, *i.e.*, disappear of their own accord, but it must be explained that such cases are mistaken for cases of "uncertain posture" which we have described above. The uncertain posture really disappears without the use of any therapeutic measures. We have never noticed that an old scoliosis, without any treatment whatever, disappears spontaneously.

Fortunately, but few cases of scoliosis attain to a marked degree of deformity. However, we do not know of any criterion which enables us at once to predict whether a scoliosis shows any inclination to grow worse. Aggravations occur even later than the twentieth year,—for instance, in pregnant women. Scoliosis destroys much of the pleasure and happiness of life in young girls, besides involving internal organs (tuberculosis of apices of lungs). The importance of early diagnosis is still much underestimated in daily practice.

Diagnosis.—A detailed discussion of the diagnosis of scoliosis may, therefore, be permitted. To secure a natural attitude uninfluenced by a sense of modesty, the clothing should be held together with a belt just below the trochanters and the breast covered with a towel fastened with a safety-pin at the back of the neck. The back of the child is placed in good light. Each spinous process and the spines and inner borders of the scapulæ are marked with blue pencil.

Comparison with a vertical line is essential to determine the presence of a curve of the spine. A weight may be suspended from the ceiling or a water-level as used by carpenters may be set up in a vertical position beside the above-mentioned line. After determining the course of this line, the lateral contours of the trunk, and especially the symmetry of the waist triangle, are care-

Fig. 84.

Drawing apparatus (after Lange).

Fig. 85.

Diopter, a part of Lange's drawing apparatus.

fully examined. Irregularity of the waist triangle lines always indicates a scoliosis of the lumbar region, even if the spinous line presents very little deviation. Examination of the scapulæ reveals whether the spines of both scapulæ are located in the same horizontal plane, whether the inner scapular borders are held at equal distances from the line connecting the spinous processes of the vertebræ, or whether torsion of a scapula has taken place. A difference in the position of the scapulæ is very frequently noted, especially in patients who in their occupation make use of only one side of their bodies, and this must not be mistaken for a symptom of paralysis of the shoulder muscles.

Finally, torsion is carefully sought for. Marked degrees are easily recognized; light symptoms of torsion, however, are often overlooked. Especial attention should be paid to torsion of the cervicodorsal and

FIG. 86a.—Lax, convex lumbar scoliosis to the right, the patient bending over to the left side.
FIG. 86b.—Scoliosis of Fig. 86a, the patient bending over to the right side.

lumbar regions of the spine. They are often the only symptoms of compensatory curvatures. If the spinous line remains straight in these regions or follows the course of the main curvature, the upper and lower

FIG. 87a.—Convex rigid lumbodorsal scoliosis to the left, the patient bending over to the left side.
FIG. 87b.—Scoliosis of Fig. 87a, the patient bending over to the right side.

symptoms of torsion are readily misjudged. In case the scoliosis as the result of this mistake be treated as total scoliosis, the compensatory curvatures at the upper and lower ends increase very quickly and affect the result attained in the main curvature.

We believe that a carefully made drawing is indispensable in making an exact diagnosis of a case of scoliosis. A great variety of drawing apparatus has been suggested. For scientific examinations, Schulthess' ingeniously constructed drawing apparatus is especially well suited. (The apparatus has been accurately described in Schulthess' text-book on Pathology and Treatment of the Deformities of the Spine.)

The apparatus which I have suggested is sufficient for the general use of practitioners. It consists principally of a vertically placed glass plate on which the lateral contours of the trunk, the spinous line and the scapular outlines are drawn life size (Fig. 84). To avoid mistakes in the transmission of lines the physician looks through a tube, the so-called diopter (Fig. 85), which is fastened vertically to the glass plate.

The **prognosis** is dependent mostly upon the already existing rigidity. To give an exact prognosis, the course the line connecting the spinous processes takes when the patient bends over as far as possible to the right and left sides must be determined. In Figs. 86a and 86b motions are reproduced from a still curable, fairly lax scoliosis; in Figs. 87a and 87b, motions from a fairly rigid and therefore incurable case of scoliosis.

Treatment of Scoliosis

Prophylactic measures, as mentioned in the chapter on round shoulders, may be employed in cases of scoliosis; strong muscles, good nutrition, correct attitude when seated, restriction in school attendance, etc., all prevent development of scoliosis to a certain degree. Playing in the open air also helps to prevent a lateral curvature, provided the games do not call for muscular activity of one side only. Lawn tennis, however, and other games of that kind may result directly in the development of scoliosis, because the right arm only is used. Such games should, therefore. as a matter of principle be played with the right and left arms alternately. The same principle should govern the carrying of school books. Children who always sleep on one side simply for the purpose of facing the light or turning from it, must be forced to change their positions by placing the pillow at the foot of the bed every other night.

Just as soon as a diagnosis of scoliosis is confirmed **treatment** must be begun. Many orthopædic authors maintain that scoliosis can be treated successfully only in orthopædic institutions, or in schools especially designed for scoliotic children.

But when we recall the fact that 25 to 30 per cent. of our own school girls suffer from scoliosis, treatment of such great numbers seems imperative, and the coöperation of general practitioners is indispensable. We will, therefore, discuss at this point the treatment of scoliosis as far as it does not pertain to special orthopædic measures. Physicians. however, who undertake the responsibility of treating a case of scoliosis

should remember that a careful drawing of each patient must be made to be used at any time as a control.

In the very first stage of scoliosis treatment—aside from regulating the entire mode of life and habits—consists in the performance of hanging exercises and equilateral action of the muscles of the back as described above in the treatment of round shoulders (1 to 2 hours daily). If the case be fully developed, such equilateral exercises are insufficient. Exercises must be added which aim at bending the scoliotic part of the spine —and this part alone—so as to stretch the shortened tissues on the concave side and strengthen the overextended erector spinae of the convex side. This may, in an imperfect way, be accomplished by gymnastics.

For example, in a case of lumbar scoliosis convex toward the left, the patient places the hands upon the head and assumes an erect position. At the command "One" the right leg is quickly and energetically bent at the knee-joint, tilting the right half of the pelvis and temporarily changing the convex lumbar scoliosis to the left into a convex curvature to the right (Fig. 88). At "Two" the first attitude is slowly resumed without exertion.

The overcorrection of a convex dorsal scoliosis to the right may be accomplished by having the patient place the left hand on the head and the right below the costal hump. At the command "One" the patient raises the left elbow, while the hand remains resting on the head. At the same time the right hand exerts strong pressure against the costal hump, bending the dorsal scoliosis over to the other side (Fig. 89).

In the case of double curvatures both exercises may be combined so that upon command "One" the lumbar scoliosis, and upon "Two" the dorsal scoliosis, is corrected and the first position is resumed at "Three." According to my experience creeping exercises, recently recommended by Klapp in the treatment of scoliosis, produce active and passive overcorrection only in rare cases of total scoliosis. We cannot consider them permissible in the more frequently occurring cases of double curvature, because the bending is not confined wholly to the scoliotic part of the spine and hence favors the development of compensatory curvatures.

A great variety of apparatus has been recommended for the mechanical correction of scoliosis. Passive and active overcorrection are simultaneously produced by the excellent but rather complicated and expensive apparatus of Schulthess.

We make use of apparatus which produces passive and active overcorrection separately; they are simple and cheap and therefore very suitable for home use. The principle underlying such apparatus may be briefly presented.

The only force which one can employ to bend a scoliotic spine over to the opposite side is the erector spinae muscle on the convex side.

This muscle is always too long, no matter upon what basis a scoliosis has developed, and therefore not quite adapted to the task of bending back a scoliotic spine. This muscle must, therefore, be strengthened unilaterally. This can be accomplished with the aid of simple resistance, i.e., gymnastics. Suppose we are dealing with a case of total scoliosis

FIG. 88.

FIG. 89.

Gymnastic exercise to correct a convex lumbar scoliosis to the left.

Exercise in the treatment of a right-sided convex dorsal scoliosis.

with convexity toward the right. The patient is seated and asked to actively curve his spine so as to produce a convexity on the left side (Fig. 90). In attempting now to lift a weight (c) which is attached to his body by means of a strap (a) and a connecting cord running over a pulley (b), he must contract the right erector spinæ powerfully on the convex side. Palpation of the patient easily reveals this contraction.

The amount of work performed may be gradually increased by adding to the weight and increasing the number of exercises.

I term this method *active overcorrection of scoliosis*.

The task of the erector spinæ is a difficult one, not so much on

Fig. 90.
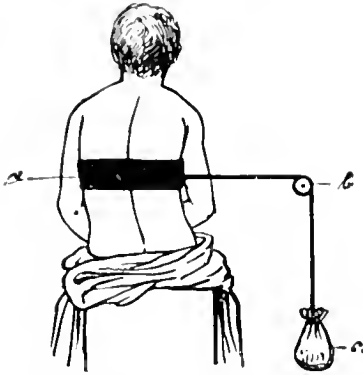
Fig. 91.

Active overcorrection of a convex scoliosis to the right.
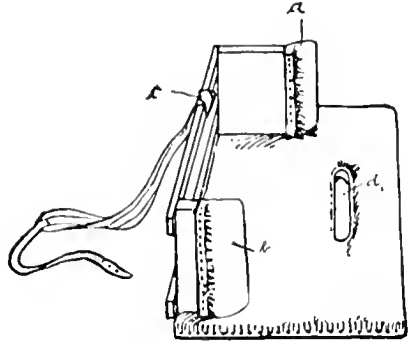
Strap apparatus (Lange).

account of the muscle's own exceptional length but due more to the shortening of the ligaments and muscles on the concave side.

The second step in a rational treatment of scoliosis is to overcome the resistance as much as possible by stretching the soft tissues.

Fig. 92.
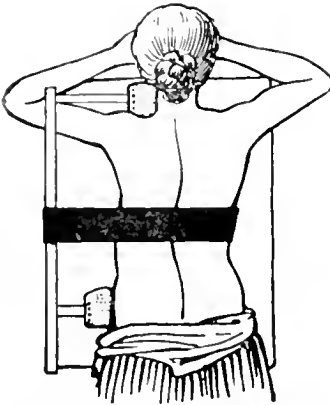
Fig. 93.

Passive overcorrection of a convex scoliosis to the right with the aid of a strap apparatus.
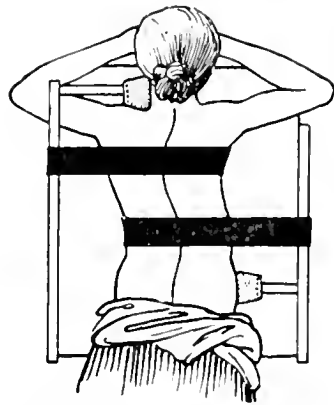
Strap apparatus for double curvature.

This is accomplished with the *passive overcorrection of scoliosis*.

I employ for this purpose a simple strap apparatus. Suppose, again, we are dealing with a case of total scoliosis convex to the right. The patient lies with the stomach on an upholstered board (Figs. 91, 92).

The left side of the neck and pelvis are lightly pressed against the upholstered pegs (*a* and *b*). Traction upon the strap, which is fastened at *c* and passes over the costal hump and through the slit underneath the upholstered board, will bend the spine as much as its laxity permits from a convex curvature to the right over to a convex curvature to the left (Fig. 92).

To avoid an increase of torsion due to the traction, a wedge-shaped cushion is shoved between strap and body. The base of the wedge is

FIG. 94.

Reclining board to correct a convex total scoliosis to the right.

located next to the spine of the convex side and the narrow edge of the cushion along the side of the thorax.

According to my experience this strap apparatus permits bringing great force to bear on the accomplishment of the passive overcorrection. Although working very energetically the patients stand the strain so well that they may remain in it daily from one to two hours.

In double curvature two straps are employed (Fig. 93). During recent years I have also made use of reclining boards which allow of a correction in the recumbent position. An example of its use in a convex scoliosis to the right is reproduced in Fig. 94. Such reclining apparatus has greater advantage, because the patients prefer the recumbent

position to a position forcing them to lie on the stomach, and because they can apply the straps themselves. Naturally, the treatment is not so easy in practice as it appears to be on paper. For example, the height and position of the shoulders, incipient compensatory curvatures, and other special points must be carefully considered.

We have purposely mentioned the gymnastic exercises first, because of their overwhelming importance in the treatment of scoliosis. But orthopædic apparatus cannot be entirely dispensed with. In certain cases of scoliosis, chiefly those of rachitic origin, the plaster-of-Paris bed

Fig. 95.

Overcorrection in bed of a right-sided convex scoliosis.

or the celluloid and steel wire bed is employed. The technic of the plaster bed has been already described on page 137.

To correct a scoliosis the plaster bed must exert pressure upon the convex side from behind as well as from the side. This may be accomplished by the addition of a cushion after the bed has been fully prepared. A more accurate correction can be made with the aid of celluloid and steel wire beds, but the coöperation of an orthopædic specialist is essential.

During the first years of life massage of the muscles of the back and daily manual reduction of the dorsal hump must be given in addition to the plaster-bed treatment; but as soon as a child becomes six years old gymnastic exercises occupy first place in the treatment. However, in all cases of scoliosis reducing beds made of celluloid and steel wire may be employed during the night at any age.

Opinions differ greatly as to the benefit of corsets. Formerly it was deemed absolutely necessary for a patient to wear a well-fitting orthopædic corset after a diagnosis of scoliosis was confirmed. Now all specialists concur in the opinion that a corset without gymnastic exercises is quite insufficient. The correcting influence of an orthopædic corset is trifling, while the damage done to the muscular tissue and often also to the function of the internal organs by the pressure of the corset is undoubtedly very great. We advise, therefore, restriction in the use of corsets. In mild cases of scoliosis we employ corsets as described on page 147 for about six hours daily, during the time of school attendance,

to overcome the detrimental influence of faulty school benches and to guard the children against fatigue. But in marked cases of rigid scoliosis a real orthopædic corset may be desirable when the muscular strength appears insufficient to prevent further bending of the trunk to the convex side and when intercostal neuralgias occur. The fitting of such corsets must be left to the skill of a specialist. However, a gymnastic treatment must always be combined with the former. The use of "corsets without exercise" is a scientific error.

B. DEFORMITIES OF THE THORAX

BY

Prof. Dr. Fritz Lange, Munich

I. PIGEON-BREAST

The chicken- or keel-shaped chest (pectus carinatum) is a not infrequent result of rachitis. A superficial examination gives an impression as if the thorax were pressed together with the hands from opposite sides. The transverse thoracic diameter is, therefore, diminished, while the sterno-vertebral diameter is increased. The projection of the sternum, after which the deformity is named, is most conspicuous.

On both sides of the sternum there is often found a flat cavity in the anterior thoracic wall extending from the second to the eighth rib. Many theories as to the development of pigeon-breast have been advanced, but a satisfactory explanation for all the changes which produce a pigeon-breast is still lacking.

It is certain that abnormal softness of the bones, which is a product of rachitis, is a preliminary cause of the development of pigeon-breast, but it is not sufficiently clear what other forces contribute to the development of this deformity. Clinical experience teaches us that contractions of the diaphragm are involved in it.

Very frequently pigeon-breast is observed in rachitic children suffering from whooping-cough which is associated with very violent spasmodic contractions of the diaphragm. Furthermore, the greatest depression along the front part of the thorax corresponds to the point of insertion of the diaphragm. But how this action of the diaphragm in particular brings about a deformity of the thorax and why the sternum alone is pushed forward as a result of these contractions while the ribs in the immediate vicinity are drawn inward, is still a conundrum.

As a rule a pigeon-breast represents only an æsthetic defect. We have never had occasion to observe that during the growing period the deformity showed any inclination to become worse. On the contrary, lighter degrees of pigeon-breast disappear without any treatment whatever. Marked deformities of the thorax. however, if unattended

remain stationary and show even in later life the rachitic symptoms of infancy.

Treatment of pigeon-breast is gratifying if started when the ribs and sternum are still soft. In a case of light incipient deformity we order the patient to assume a recumbent position upon a hard mattress. The mother places her hand upon the child's sternum and presses upon the thorax while the child takes deep inspirations and expirations. The child is also told to perform the various gymnastic exercises recommended in the treatment of round shoulders.

Should the parents be dissatisfied with the improvement, an orthopædic apparatus must be employed. Hoffa recommended a spring, similar to one used in trusses, which encircles the thorax and terminates at each end with a pad. This approximates the sternum and spine by means of elastic pressure. We have personally experienced good results early with orthopædic corsets to which a cushion was attached to exert pressure upon the sternum from before backward.

II. THE FUNNEL CHEST

A round or oval depression in the median line of the anterior wall of the thorax is known as funnel chest. The depression may be only a small cavity, but it may also attain to such a size as to receive easily the fist of a man.

The depression begins in the upper region of the sternum at the point of its articulation with the second rib (Ludwig's angle). The greatest depth of the cavity is located generally several centimetres below the inter-mammillary line. Further below, the wall of the funnel rises again to end somewhere between the xyphoid process and the navel. The extension of the funnel laterally varies likewise. In pronounced cases the cavity may extend to the nipples.

From the description of the location of the funnel it may be easily inferred that the deformity is caused by an abnormal condition of the sternum, which presents an arched curvature with the convexity inward. The condition has also been termed *kyphosis of the sternum*.

The anterior ends of the ribs are bent in the opposite direction, the convexity facing to the front along the border of the funnel.

It is manifest that, owing to the deformity, the sagittal diameter of the chest is more or less diminished. In marked cases it is not more than 3 to 4 cm.

As a rule the transverse diameter of the chest is increased.

Funnel chest may exert an influence upon the location of organs within. Some authors have observed displacements of the heart to the left as far as the anterior axillary line and a lowering of the inferior pulmonary border, due entirely to the funnel-shaped condition of the

sternum. The functions of the thorax and abdominal organs are, as a rule, not impaired.

Etiology.—Opinions as to the cause of funnel chest differ widely. Recent observations seen to substantiate the hypothesis that funnel chest is caused by abnormal intra-uterine pressure. In some cases the chin, in others the elbow or a foot has been accused of producing the detrimental pressure. The theory is further supported by the fact that in quite a number of patients with funnel chest other deformities are evident, for example, congenital dislocation of the hip, club-foot, and congenital deficiency of the pectoral muscle, all well known as intra-uterine disturbances due to overpressure and weight.

Other authors consider funnel chest to be a result of faulty development, a congenital defect.

To aid this hypothesis, reports of different cases of funnel chest in the same family are published, claiming that heredity plays an important rôle in a number of them.

Ebstein assumed that, owing to its slow growth, as compared with the other parts of the chest, the sternum does not attain to a full development. Exception must be taken to the correctness of his opinion, inasmuch as in all reported cases the sternum itself was not thrust back in toto, but, as Byrston pointed out, presented only a kyphotic curvature.

The **treatment** of funnel chest is confined to a few measures. It has been attempted by means of forced expirations, as in blowing a horn, to thrust the depressed parts forward by exerting pressure from within upon the sternum and the anterior ends of the ribs.

Improvements after prolonged deep breathing exercises have also been reported. However, complete recovery has not been observed up to the present time.

Adhesive plaster bandages applied for the purpose of raising the sternum from the outside are, in our opinion, entirely ineffective.

Thus far the application of a vacuum has produced the best results. We placed a bell-glass over the depressed part and established a vacuum with a pneumatic pump; elevation of the funnel was immediately observed.

The technic of the method is rather complicated, because of the difficulty in adapting the sides of the bell-glass to the uneven surface of the anterior chest wall. This is accomplished by introducing a thick ring of Unna's zinc paste between the glass and the thorax.

C. DISTURBANCES OF GROWTH IN THE UPPER EXTREMITY

Mechanism of Development.—The yielding of the soft bone to the muscular traction is the chief cause of the deformity, while a lesser influence may be due to the weight (in creeping) or the adaption of the bones to the lateral contours of the body.

Biology teaches us that the upper extremity in order to change from a dorso-ventral fin to a grasping organ must undergo philogenetically a number of rotations, circumductions, and torsions. This fact, together with the observations of Holl that such rotations also take place during embryonal life, offers a suitable explanation of the postfetal, corkscrew-like distortions which the humerus and forearm of a softened upper extremity present. This condition arises mainly from traction of the dominating group of muscles (grasping motion). (Biological prevalence of the pronator and flexor muscles.)

As a rule the deformities follow the already existing physiologic curvatures and torsions.

Marked cases necessitate surgical intervention (osteotomy), to which, however, recourse should not be had until full recovery from the disease, because of the danger of a repetition of the deformity. The weak bony tissue is very frequently exposed to fractures which usually result in deformities (see Spontaneous fractures).

Two deformities are occasionally noticeable at the elbow and are called cubitus valgus and cubitus varus.

Cubitus valgus is the term for an outward deviation of the forearm (with radius and ulna parallel).

Cubitus varus is the opposite deformity. Cubitus valgus is to a certain degree a physiological feature and, in general, is the result of adaption of the arm to the broader pelvis (Heubscher). Abnormal softness of the bones would naturally change such normal conditions to pathologic disturbances. But on the other hand, distortions at the lower part of the diaphysis of the humerus, as well as fractures in this region, may create similar deformities.

The rather frequent occurrence of overextension in the elbow-joint is certainly to be connected with the abnormal laxity of the articular ligaments. Such children present, furthermore, an abnormal laxity of other joints, voluntary dislocation of the metacarpo-phalangeal joint, voluntary dislocations of the fingers, and flexibility of the ankle. Therapeutic intervention is hardly called for in such cosmetic defects.

It must be noted that children should be taught not to increase the flexibility of joints either intentionally or in a playful mood (cracking fingers).

Madelung's deformity of the hand consists in a curvature of the lower end of the radius towards the thumb, producing an apparent volar deviation of the hand. Heredity seems to play an important part (Estor). De Witt-Stetten reports a case of opposite deformity with dorsal deviation of the hand (Kirmisson).

Occasionally we come across habitual or voluntary dislocations of the metacarpo-phalangeal joint of the thumb which may attain to such

a degree that surgical intervention becomes necessary. In cases where laxity of ligaments is combined with a slipping of the tendons of the extensors, marked disturbances in important muscular action of the thumb are elicited (inability to extend and abduct the thumb). Capsular folding and replacing of the dislocated tendons relieve these symptoms.

Dislocation of the tendons of the extensors occurs occasionally in other fingers and necessitates similar operations.

D. DISTURBANCES OF GROWTH IN THE LOWER EXTREMITY

The developmental disturbances in the lower extremity are of greater importance and frequency, especially in the parts preëminently exposed to the force of gravity.

I. COXA VARA

Etiology.—Judging by its crane-like shape, the neck of the femur is destined to bear the main weight of the body (J. Wolff). The structure is correspondingly strengthened to prevent depression. The angle formed by the femoral neck varies in different races from 108° to 140°, but always more than 90°. It remains rectangular in quadrupeds and in bipeds walking with the body bent forward, in birds and in anthropoids.

Nor did the forerunners of our race enjoy the present erectness of the neck of the femur. Such erectness, combined with an increased antitorsion, must be looked upon as a result of adaption to the erect gait. (See Congenital dislocation of the hip, Fig. 96.)

If the structure of the femoral neck be weakened in any manner, either by softening processes (rachitis) or by external force (fracture), a shrinking of the femoral neck takes place as a result of the subsequent

FIG. 96.

a, femur of a modern human being with a large angle of the femoral neck and normal antetorsion; b, d, Homo Spy: the angle of the femoral neck decreases with a diminished antetorsion; c, Homo Neanderthal: the angle is about 90°, antetorsion has likewise disappeared. The gait of this race was certainly not entirely or permanently erect, a fact which may be proved by the increased physiological or better biological curvatures of the bones of the thigh and leg.

action of gravity and the traction of the trochanter muscles of the pelvis. Hofmeister has termed this condition coxa vara.

There are a few cases of *congenital coxa vara* on record (Hoffa) which must be considered as atavistic relapses (vara congenita).

The *rachitic coxa vara* of younger children is characterized by a

deformity of both femoral diaphyses (Hoffa) occurring at the same time and in the same manner (Fig. 98).

The later developing *coxa vara statica* pertains principally to later childhood and adolescence, resulting in a depression of the femoral neck alone. The strong femoral bone, now less burdened, does not follow the distortion any longer. The main cause in this case is a shifting of the epiphyseal junction between the neck and head (Kocher).

Fig. 97.

Congenital bilateral coxa vara. Child four years old. Angle of femoral neck below 90°; thighs are not deformed. Impairment of gait was observed when the child began locomotion. No other symptom of rachitis.

The *coxa vara traumatica* may be the result of a faulty opposition and reduction of a fractured femoral neck (see Fracture of the neck of the femur).

The **symptoms** consist of an impairment of gait, similar to that in dislocation of the hip, and of limping and waddling of the bilateral type (Trendelenburg), and are elicited by disturbances of the muscular mechanism due to the elevation of the trochanter above Roser-Nélaton's line (see Dislocation). However, the uncertain step, one of the main symptoms of dislocation, is missing.

Combined with the depression is a detorsion of the neck, both resulting in a modification of the range of motion.

Abduction of the leg is prohibited on account of the shortening of the adductors, and even more as a result of the obstruction coming from

the elevated trochanter itself. The detorsion produces an outward rotation. Inward rotation is, therefore, restricted. Flexion is possible only when outward rotation takes place at the same time.

But aside from these restrictions, the motions are not limited. Moreover, the inactive gluteal and abductor muscles become atrophic.

Subjectively, the patient complains of pain in the hip which appears to be like that in flat-foot, and probably results from the disproportionate strain on certain groups of muscles and ligaments. The affected

Fig. 98.
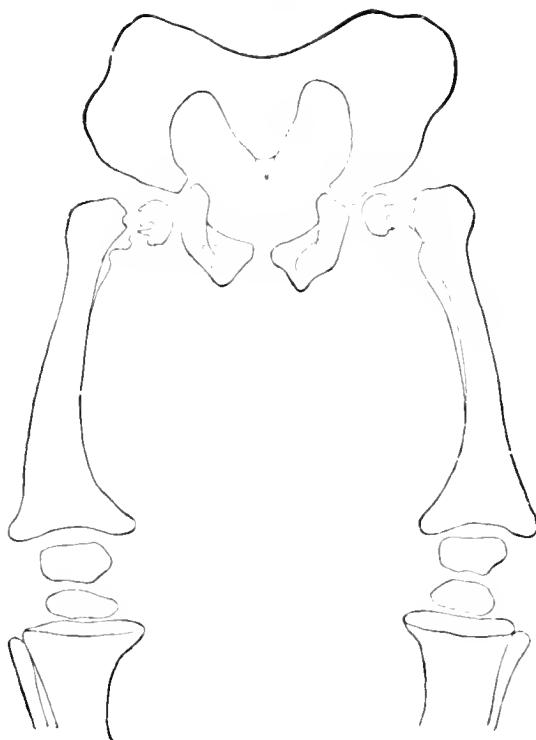
Rachitic coxa vara in a child four years of age. Marked rachitis; the thighs are deformed in the same manner as the femoral neck.

leg is limited in motion, tires quickly, and presents in a gradually increasing degree the above-mentioned disturbances of locomotion.

The **diagnosis** is not difficult when careful attention is given to the history.

In cases existing since birth, the affection must not be mistaken for congenital dislocation of the hip. A firmer gait, palpation of the head in its normal position below the artery, and, finally, a Röntgen picture permit of an exact diagnosis in patients with symptoms which are otherwise similar.

Coexisting rachitis may manifest itself by accompanying symptoms. The existence of former fractures is given in the history. Only coxa vara statica, which develops later, calls for an exact differential diagnosis to avoid mistaking it for hip disease.

Pain, tenderness, and limitation of the range of motion may indicate coxitis. However, outward rotation is unrestrained, and in this position flexion and extension are painless. In difficult cases the Röntgen picture must decide whether a depression of the femoral neck has taken place or not.

Secondary coxa vara, accompanying old dislocations of the hip, has already been mentioned in the discussion of congenital dislocations of the hip (Spitzy).

Treatment.—Prophylaxis is the most important factor in treatment of coxa vara.

Rachitic children are to be kept in a resting position as much as possible during the florid stage to prevent curvatures. In fractures of the femoral neck the plaster-of-Paris bandage must be applied in over-corrective position and only a gradual increase of weights allowed on account of the softness of the callus tissue (apparatus to relieve the weight).

In coxa vara statica, at the very onset of the initial symptoms a relief of the increasing demands upon the leg must be sought (rest, change of employment).

Further experiments to correct a developed case of coxa vara by means of a bloodless operation were less successful. Lorenz's suggestion of inversion may be attempted in cases of faulty reduction of fractures of the femoral neck. After breaking up the fibrous scar tissue, he places the trochanter below the spine in abduction without concern about any osseous remnants left in the acetabulum. His idea is that the attitude of adduction and the deficient support are the chief causes of the disturbances of locomotion.

After transposition, fixation is brought about with the aid of permanent bandages.

In other cases operative treatment is indispensable.

Frontal osteotomy is performed in the vicinity of the joint to allow an increase of the angle of the neck by the application of subsequent correction bandages (Hofmeister, Hoffa, Codivilla). Opening of the joint must be avoided on account of resulting stiffness. In cases of depression of traumatic origin, suture of the bone or resection of the fragment of the head may be employed (Whitman).

In developed cases of rachitic coxa vara, Lange advocates extension with heavy weights overnight and exercises to increase the range of abduction.

The opposite depression of the femoral neck, so-called *coxa valga*, after Turner, is of no practical importance in pediatrics and may be mentioned here just for the sake of completeness.

The *deformities of the femoral diaphysis* are the result of exaggeration of the normal curvature; they imply, therefore, an increase of the normal curvature of the femoral bone with the convexity toward the front. It is produced by a predominance of the flexors, which, as remnants of the biologically older and constantly flexed attitude of the knees, are more strongly developed than the extensors.

Compared with the deformities of the leg they very seldom necessitate operative intervention; cases of less marked degree are better left to themselves for correction during growth (see Deformities of the leg).

A deformity of the bones forming the knee-joint is of greater importance because of the marked disturbances of the erect posture and gait.

II. GENU VALGUM (KNOCK-KNEE)

Genu valgum is an outward deviation of the leg. The leg appears to incline inward from the side in the region of the knee and forms there an angle opening outward. When both legs are affected the knees are thrust together in the form of an X (x-knee or knock-knee). The ankles stand apart from each other in recumbent position as well as in the erect posture, especially if the patella is accurately placed at the front. A photograph, Röntgen picture, or a drawing of the curvatures will give the best information as to the degree of curvature, but the patella must always be kept in the frontal position. The distance between the ankles may also be made use of in the examination as well as consideration of the angle of the knee base (Mikulicz). In all cases the exact frontal adjustment of the axis of the knee-joint is most important because the real condition of the case may be concealed on account of rotation at the hip-joint.

Anatomically the deformity pertains to the lower part of the diaphysis of the femur as well as the upper part of the diaphysis of the tibia. The epiphyseal line takes an oblique course, giving the internal condyle, which rests upon it, the appearance of being much more elongated than the external. The upper end of the tibial diaphysis presents the same deformed condition, and in some cases to such an extent that it may be claimed as the main cause of the deformity (W. Blanchard). Since Albert's investigation we are accustomed, at least in all pronounced cases, to find changes involving the whole of both extremities. All weak parts become deformed, following the course of the assumed faulty attitude. To the obliquity of the epiphyseal line must be added a noticeable enlargement of the internal condyle, which undergoes a dispro-

portionate strain and thickening at this point as a result of the rarefaction and a diminution of the external condyle.

With maximal flexion the elevation of the internal condyle is distinctly noticeable and there are also an abnormal laxity and a slight overextension of the capsular ligaments (Lange).

Etiology.—The affection, in the first place, proves to be the result of the inability of the bones to respond to the difficulties of equilibrium which the body must overcome at the time of assuming the erect position (posture of young children with feet wide apart which calls for a great horizontally acting component whenever the legs are held in such

Fig. 99.
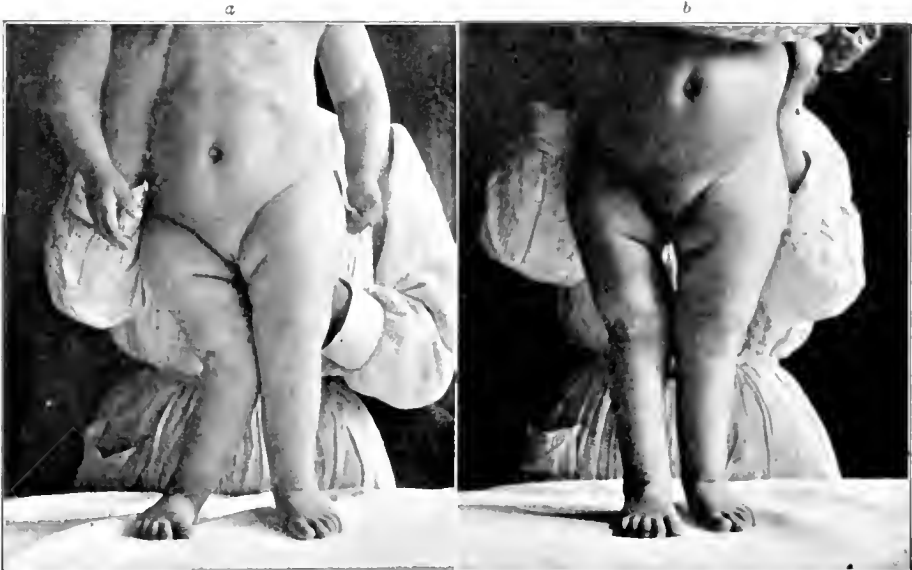
Genu valgum of the right leg. Child four years old. *a*, marked abduction of the leg, the height of the curvature in the metaphysis of the femur, the internal condyle elevated. The foot assumes a compensatory varus attitude. *b*, the same case eight weeks after epiphyseotomy (six weeks reducing bandage, the following two weeks splint during the night).

oblique attitude). Secondly, it results in an increase in the strain on the bones which are not yet properly fortified. The body yields at the very point where weight becomes a most critical factor (genu valgum of children) or where eventually remnants of curvatures of a former period exist (static genu valgum adolescentium).

Symptoms.—Genu valgum is most frequently observed in small children. About 50 per cent. of all children present such deformities during the first stages of locomotion. Measurement of the distance between the ankles is possible in the recumbent position, and as a rule one leg is more markedly deformed than the other. The deformity disappears when the knee is flexed, due to a decrease of the open angle by half, or because of a slipping backward of the tibia from the oblique

condyles (Lange). Standing a child on its feet decreases the valgus deformity. At the same time it is observed that the child tries to turn its knees toward the front or the back to avoid their knocking against each other. In mild cases a backward torsion always takes place. The foot is turned inward, aided partly by a torsion of the hip and partly by adduction of the foot (walking with feet turned in).

Only when a case becomes more pronounced, *i.e.*, when genu valgum combines with an analogous pes valgus, is an outward torsion favored.

Fig. 100.
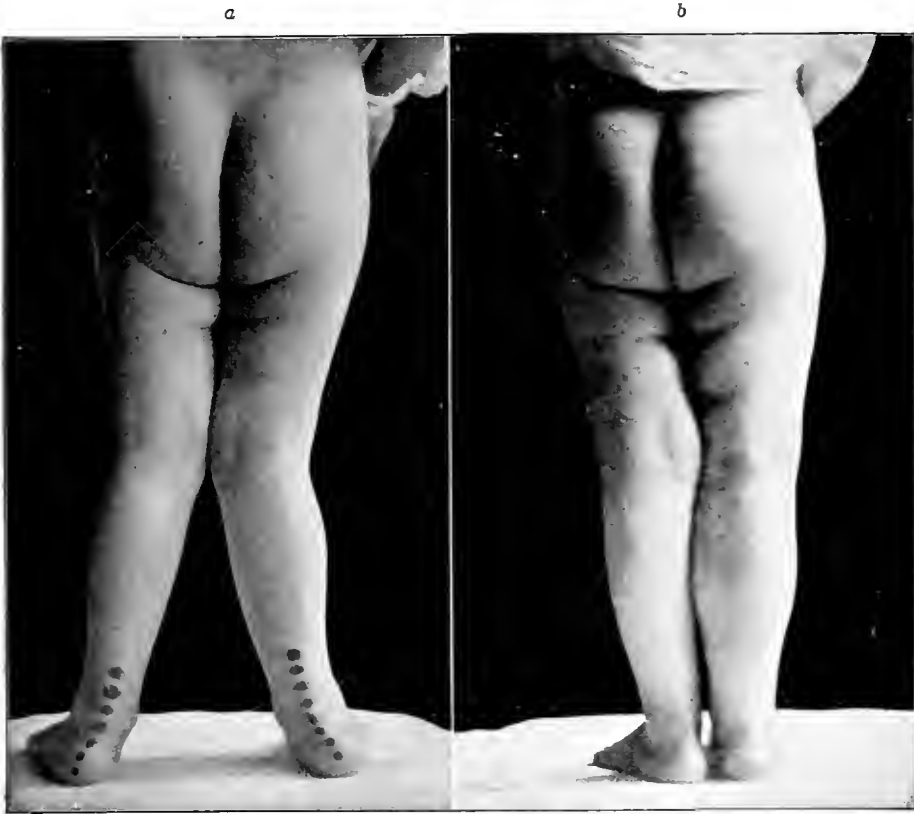
Bilateral genu valgum. Child eight years old. *a*, great distance between the ankles (26 cm.), also evident outward deviation of both feet (pes valgus). *b*, six weeks after epiphyseotomy, performed on both legs, immediately after discontinuation of the correcting primary bandage.

In very severe cases adduction and supination of the foot reappear, often being the only help in the attempt to walk on the soles (pes varus compensatories, Luksch). (Figs. 99, 101.)

The inward torsion is thus to be considered a natural correction and must never be corrected itself.

These objective symptoms in children are accompanied by much complaint of fatigue and discomfort, and by pain in case of overstrain.

The **diagnosis** is easily made after examination. It is important always to think of a case of genu valgum when parents bring their children to the physician with the complaint that they walk with their feet turned in.

Treatment includes chiefly two points for consideration in small children:

1. Prophylaxis.

2. Spontaneous recovery.

Small children with soft bones must not be carried around, for the arms of the nurse may deform the bones. A reclining position either on

Fig. 101.

a, genu valgus dexter; b, genu varus sinister (marked rachitis in a girl eleven years old). a, deviation in genu valgus most conspicuous in the femur; however, the tibia and fibula are likewise bent outward just below the upper epiphysis. Pes varus compensatorius. In genu varus sinister the main part of the curvature appears in the upper third of the leg. b, eight weeks after epiphyseotomy of the right tibia and osteotomy in the upper third of the left tibia. To compensate for the outward deviation of the right tibia, after epiphyseotomy, overcorrection in the femoral epiphysis was maintained.

the back or the stomach must be favored, and circular as well as lateral elastic traction must be avoided. I employ garters at the back and the inside. The front ones very often cause extensions. As soon as a valgus deformity is noticeable parent and physician should give up hope of spontaneous recovery.

How do rachitic deformities heal? Nature invariably tries to overcome one curvature with a compensatory second curvature. In knock-knee a child attempts by inward torsion of the foot to avoid the angle formed by the knee and to bring the feet nearer to each other. Thus an inward curvature of the leg is developed. Frequently we find traces

of old knock-knee in the form of knees bent markedly inward with a peculiar correcting curvature of the tibia inward, and just below a sign of correction which had taken place earlier. Nature occasionally goes too far—an original varus deformity of the femur (bow-leg) may be compensated during further growth by a genu valgum, to be again corrected by a compensatory curvature of the leg (observed by the author).

All these corrections take place only when the softness of the bones has not become too extreme or the deformity too pronounced. Otherwise any further weight increases the deformity. Spontaneous recovery must be aided in every way and not prohibited by the introduction of

Fig. 102.
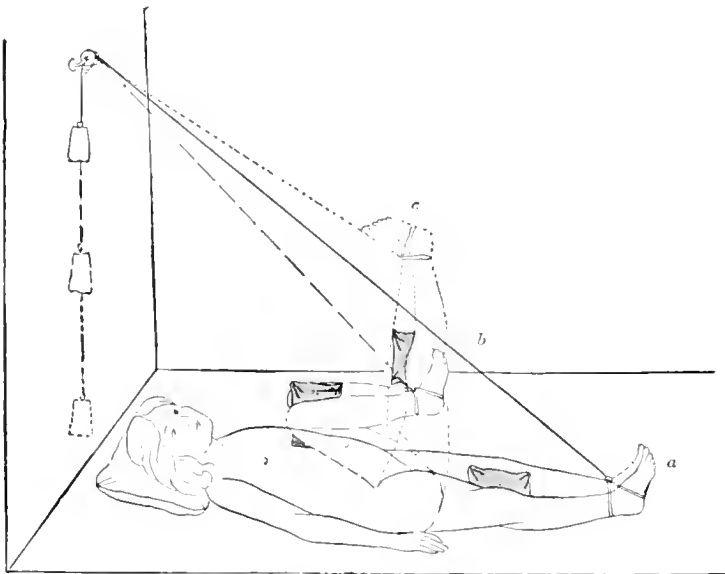
Active gymnastics in genu valgum, according to Lange. *a*, both legs are stretched with a 10-lb. weight pulling in the opposite direction. A cushion is placed between the knees. Both patellæ are facing upward, the legs are parallel. *b*, the knees are drawn up to the trunk as far as possible (maximal flexion in hip and knee-joints). *c*, the knees are stretched while the thigh forms a rectangle with the hip. Later the extended knees return to the old position *a*.

"modern" cosmetic appliances by interfering and unreasonable parents. To insist that children who walk with feet turned in should favor a gait with the feet turned outward is only aiding the development of genu valgum. After the elimination of genu valgum, walking with feet turned inward disappears of its own accord. It is more important to see that children stand with the heels touching each other, because with the feet wide apart the great weight component tends to increase the deformity (see Etiology).

In order to employ correct therapeutic measures we must distinguish the genu valgum of early childhood from that of a later period

and also take into consideration the social condition in cases of prolonged treatment.

In small children, static treatment and exercise are to be preferred.

A drawing of the contours in the recumbent position and frontal fixation of the axes of the knees permit an accurate judgment of the actual condition. Arch supporters of celluloid and steel wire or elevation of the inner side of the sole forces the foot into a supinated position and separates the knees.

The preparation of arch supporters made of celluloid and steel wire is described on page 187 (Fig. 106). If reduction exercises and gymnastics with weights are added, recovery may be expected, providing the cases are not too severe. In mild cases splints are superfluous. After three months a drawing of the contours is made to find out whether or not improvement has taken place. In nearly all cases a decrease in the deformity is observed.

In pronounced cases, or in cases not benefited by the above mentioned measures, I would choose a thorough correction by operation or by the bloodless method in preference to a treatment by splints covering several years.

A reducing plaster-of-Paris bandage, in combination eventually with a preceding epiphyseotomy or osteotomy, will eliminate the deformity. The plaster bandage maintains the legs in correct position until recovery, and light splints may be employed in the after-treatment.

In treating genu valgum in older children Wolff used a series of temporary bandages with which correction is attained in a bloodless manner.

I prefer this method of correction by means of several successive bandages to the articulating reduction bandages on account of its greater simplicity and practicability. The laxity of the articular ligaments, especially of the external ones, which is always associated with this treatment, must be looked upon as a disagreeable incident. Methods, therefore, by which a correcting fracture of the lower end of the diaphysis is effected by osteoclasts are of much greater value. Keiner seeks to separate the epiphysis in this manner, aiding the separation by a subcutaneous division of the thickened periosteum (epiphyseolysis).

Division of the bones with subsequent correction of position was most successful in fully developed genu valgum of older children. MacEwen's osteotomy, starting from a longitudinal incision at about the level of the internal condyle, separates the tissues down to the bone, and the bone itself, transversely at the depth of the wound.

It is, of course, necessary to divide the bone which is most deformed, and the point of division must be as near the vertex of the curvature as possible.

This advice should guide us in most of our cases, but after division of one bone there always remains a slight corresponding deformity in the other articulating bone. In case both bones are involved to the same extent they must be treated alike, otherwise an overcorrection of one bone is sufficient. Therefore a discussion of the seat of the deformity is eliminated, at least in regard to therapeutic measures.

The plane of division must be as near the vertex of the curvature as possible, and is located usually in the femoral diaphysis.

Brunn, therefore, removes the plane of the condyles and performs here a subcutaneous transverse osteotomy, starting from the external condyle.

These considerations finally induced me—since 1900—to divide the diaphysis and epiphysis transversely along the cartilage. Fear was at first expressed that disturbances of growth would ensue. It was fortunately soon dispersed. Out of 140 cases on which I operated not one showed any such disturbances whatever.

Recent investigations (Redinger) on rabbits proved that a delay in growth takes place only for a short time immediately after operation, but is made up again in about two years, owing to the rapid growth of a rabbit's bones. In a human being, therefore, where the rapidity of growth is twenty times less than in a rabbit, retardation must certainly prove slight. The delay of growth in a human being is thus not manifest. The insignificant operation is performed as follows:

Mild ether narcosis. A narrow chisel with a transverse handle is driven into the limb parallel to the longitudinal axis in the region of the external condyle. Upon reaching the bone the periosteum is divided, the chisel turned transversely, and with gentle force pushed through the cartilaginous tissue, which is found quite easily, until it reaches the skin of the internal condyle. In the same manner, by partly withdrawing the chisel the other cartilage and periosteum are divided. A layer is left untouched at the popliteal space on account of the dangerous proximity of the popliteal artery. The chisel is now withdrawn entirely, the small wound is not sutured but bandaged, reduction is easily accomplished, and the cleft between bone and cartilage may be distinctly felt through the skin.

The duration of the operation is three or four minutes; five minutes suffice for operation on both sides. A plaster-of-Paris bandage is applied, and before it sets a cushion is placed between the knees; the lower ends of the cast are covered with gauze bandages.

The bandage remains in the overcorrecting position until it is firm. It is then turned into a permanent bandage and not interfered with for five or six weeks. During the last three weeks the child may walk around. After four weeks the bandage is shortened and the ankles freed.

Two weeks later the bandage is taken off entirely and eventually supplanted by light splints to be worn overnight. The latter consist of the longitudinal halves of the plaster cast. Lange employs similar splints made of celluloid from an overcorrecting model. In about ten days the knee flexion, which is at first painful, may be used without trouble. I never observed any permanent disturbance of locomotion arising from the knee.

I prefer this small and nearly bloodless operation to epiphyseolysis, because of the possibility of accurately determining the point of correction. It is superior to all other operations on the bone on account of the ease and rapidity with which it can be performed, and also because here the plane of division actually corresponds to the vertex of the curvature (see MacEwen).

The appropriate *time for the different therapeutic measures* may be stated as follows: Static corrective measures can be employed up to the fourth year with success.

Supinating supporters, correcting exercises and, in more pronounced cases, splints preceded by reducing bandages are required. The rigid splints are the best (Thomas); those which are flexible in the region of the knee must have well-made articulations, otherwise the splint soon develops a deformity similar to that of the leg. The result must always be controlled by a drawing of the contours.

Should this treatment be insufficient, or for other reasons impossible, or in case the deformity is so marked as to produce a limitation of locomotion and a development of secondary deformities (deformity of the tibia, flat-foot), the harmless little operation correcting the deformity in a radical manner must even be performed in early childhood.

This operation was of great benefit in many cases where social circumstances did not permit of a prolonged treatment and observation. It restored straight legs to the children and made them independent of the indolence or intelligence of parents, who always look upon a permanent treatment in a very sceptical manner, as a rule not having time and sense enough to devote to such conditions.

The older the children the more necessary it becomes to turn from epiphyseotomy. In these cases the employment of hammer and chisel to divide the opposing bony structures appears sometimes inevitable. Thus far I have not observed any disadvantages of this method.

A later investigation of 140 cases operated on during the preceding ten years yielded the following results: Ninety per cent. permanently cured and the remainder decidedly improved. In one case only a mild distortion of the epiphysis backward was noticed and that was early corrected by the bloodless method. Not one case presented a shortening or any other disturbance of development.

III. GENU VARUM

This deformity is just opposite to genu valgum. In erect attitude ankles and heels are in contact while the knees stand wide apart (bowlegs). Femur and lower leg participate equally as a rule in the distortion. The foot is correspondingly pronated upon the leg (see the accompanying coxa vara rachitica).

The deformity is mostly bilateral; in some cases it is combined with genu valgum of the opposite side.

In regard to **etiology** it may be stated that some children are born with bow-legs, a condition which becomes aggravated with the increase of weight. As mentioned above, I had occasion to observe that the original outward bowing of the femur was compensated for by an outward bowing of the lower leg.

Spontaneous recovery from this deformity is very frequent, and a physician is seldom consulted in these cases because of the well-known fact that children "outgrow" the deformity, provided it is not too pronounced.

The **prophylaxis and treatment** are identical with the measures adopted for genu valgum. In mild cases recovery may be left to nature. In addition a general antirachitic treatment

Fig. 103.

Child four years old with symptoms of arrested rachitis. The deformity is caused by the lower end of the femur and chiefly by the outward bowing of both tibiæ. The foot assumes a compensatory flat-foot attitude. Bilateral osteotomy and fracture of the fibula corrected the deformity.

must be instituted. Sun baths, salt baths, and a diet to prohibit too large a production of fat are indicated.

Braces that are applied to overcome the deformity by traction or pressure with springs are favored, but are not very efficient. I employ them to avoid relapses after operation or corrective osteoclasis or osteotomy.

The point where osteotomy should be performed depends on the vertex of the curvature. In uniform marked deformities the middle of the femur and lower leg (Fig. 103) are the most suitable points for operation (see following section).

IV. RACHITIC DEFORMITIES OF THE LEG

(See Stoeltzner, Rachitis, vol. ii.)

These affections necessitate surgical intervention more frequently than any of the above-mentioned deformities. Although presenting a great variety of forms they generally follow certain types.

Mechanism of Development.—They are caused partly by an aggravation of the physiological curvatures and torsions and are partly the result of the strength of certain muscle groups which belong to an older system biologically and are kept in balance only by an intact bony structure. With the yielding of the levers greater muscular activity and traction are immediately noticeable (outward and anterior bowing of the femur, anterior bowing of the lower leg).

Furthermore, mention must be made of the great number of deformities which are produced by the influence of the weight of the body upon the flexible bony apparatus (see Genu valgum, Coxa vara), and combined with them of those deformities of the lower leg which for static purposes correspond to the deviations of the axis of the extremities. Thus, outward curvature of the leg accompanies genu valgum, or outward bowing of the legs which, for the sake of equilibrium, develops by means of self-correction and finally leads to compensation of the original deviation. The same may be said of pes varus compensatorius (walking with feet turned in) and of genu recurvatum with marked bowing of the thigh. Among these cases we find a number of varieties which, as the result of the repeated assumption of certain attitudes, such as carrying something under the arm or sitting with the legs crossed, must be looked upon as remnants of traumatic lesions (incomplete fractures).

The structure of the bone naturally adapts itself to the changed condition (Wolff). It becomes firmer on the concave side, which endures the greater strain, and more porous on the opposite side. The transverse section presents a different picture, as shown by the sabre-like shape of the tibia.

The deformities pertain in most cases to both bones of the lower leg, but they are always more pronounced in the tibia than in the fibula, especially in those cases of distortion which are the result of the force of gravity, which exerts less influence upon the shape of the near-by fibula.

The soft tissues also undergo various displacements, the most conspicuous of which is the cord-like course of the tendo Achillis, which covers the distorted bone like a tightened bowstring.

The **etiological** causes are processes which soften the bone and secondarily necessitate a change in its external appearance. Rachitis, with all its degrees of intensity and its different varieties, may justly be claimed the main factor in the production of these frequent deformities.

Although often manifest in infants, the majority of deformities appear after the first year. With the increasing softness of the bones the deforming factor increases until it reaches its maximum with the *flexibilitas cerea*. A strengthening of the osseous structure commences when the disease becomes stationary. The former abnormal softness gives way to an extraordinary firmness and hardness (eburnation).

At the same time those forces take a part which later on bring on a spontaneous correction; compensatory curvatures are produced as a result of efforts at balancing (see Compensatory curvatures of the spine). The act of locomotion is made easier by a spontaneous correction in placing the foot upon the

Fig. 104a.
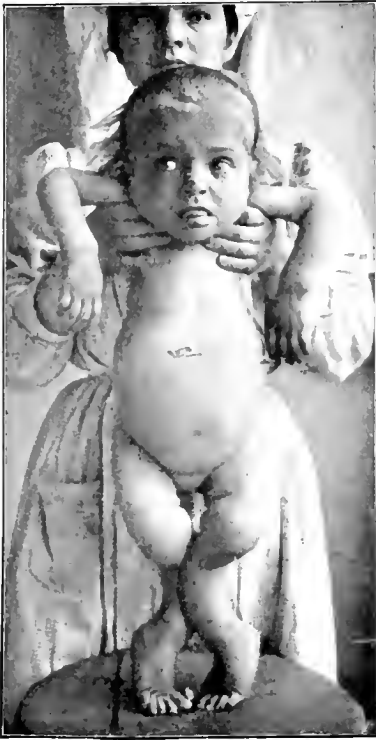
Fig. 104b.

Fig. 104a.—Marked deformity of the lower extremities, especially of the lower leg. The picture from the front shows a pathological outward bowing of the femur and a genu valgum with simultaneous inward bowing of the tibia and fibula. Child four years old.

Fig. 104b.—Profile showing an existing anterior bowing of the femur and a compensatory genu recurvatum (anterior bowing of the upper end of the tibia). Child three years old. (Operative correction by various osteotomies.)

ground, and in many cases it is in this way made possible (see Walking with feet turned in). The rapid longitudinal growth during this period must be added as a further factor by which the curvatures are straightened. Later these deformities disappear entirely.

The deformities in which there is no compensation do not recover spontaneously. But if there is a marked outward curvature in addition the result is an increase of the deformity at every step. Those cases, and others of angular curvature in which a favorable attitude of the

surrounding structures and joints is not able to bring about an actual correction, must be restored as early as possible. Even if rachitis is not entirely eliminated there is danger of further increasing the number of deformities.

Prophylaxis and Treatment.—One's experience must decide when an operation is necessary. An exact control by a drawing of the contours and eventually by photographic or X-ray pictures may enable the less experienced physician to form an opinion as to the tendency and outcome of the deformity.

As long as rachitis is in the florid stage some advice bearing on prophylaxis may be in place. General anti-rachitic treatment, air and sun baths, sojourn at the seaside, dietetic measures, no weighting of the limbs, no carrying nor much sitting down, a flat structure to sleep upon, and restriction in walking and standing are suggested. Should the deformity increase, corresponding splints and braces and apparatus to relieve the strain must be employed. Special care should be taken in pressing and readjusting the bones which, as it were, suffer from malnutrition and lack of resisting power. The actual correction may be postponed until a later period, especially when, owing to the state of intelligence and social environment of the parents, there is doubt as to the strict and prolonged enforcement of the physician's orders.

As a rule one should postpone operative measures until the fourth or fifth year, and occasionally until assured that the rachitis has passed the florid stage. Thereafter a radical correction of the deformity is to be preferred to a tiresome and weakening treatment with braces. Braces and strapping and finally the prolonged elimination of the weight of the body have a tendency to produce atrophy of the muscles. Even well-fitting apparatus cannot overcome these disadvantages.

In addition, it may be stated that the great expense and the accuracy necessary in handling the apparatus render such treatment prohibitive in general practice.

Osteotomy performed at the vertex of the deformity and fixation by means of an exact plaster-of-Paris bandage call for treatment extending about six weeks and are not dangerous when performed by an experienced physician and always give good results. The weakening of the muscles which is produced by the plaster cast is compensated for by the short period of treatment.

V. DISTURBANCES IN POSTEMBRYONIC DEVELOPMENT OF THE FOOT

Pathology of the Commencement of Locomotion.—The development of the foot from the embryonic mass in the first few weeks of embryonic life is soon followed by the formation of the lower leg and finally of the thigh. On the fifteenth day conditions are further advanced and

after a month all bones present a fibrous structure, but separation into single parts is still lacking. This division and the formation of cartilage in the different parts of the skeleton occur during the first few months, and such torsions take place as the attached fin must of necessity perform in order to occupy later the position of a human leg and foot. The rotation is limited as a rule to the hip and femur. However, both tibia and fibula present a mild degree of crossing and the foot assumes an entirely supinated attitude. The soles of the feet face each other, most children being born in that condition. All motions originate from this attitude, club-foot in extreme form, but the foot always returns to the position from which it started. This attitude is habitual in 80 per cent. of infants; in the remaining 20 per cent. the attitude of the foot varies by indifferent degrees even to the anomalies which we term congenital flat-foot and talipes calcaneus

The foot of the newborn is very delicately formed and its different joints are very flexible. Most conspicuous is the finger-like flexibility of the toes (ability to abduct the big toe). When a foot is surrounded by a great quantity of fatty tissue it appears to be flat, a condition which has given rise to the contention that all the newborn had flat feet. I have proved by means of frozen sections of specimens that the osseous structures of the normal arch of the foot are alike in the newborn and in adults. Apparently flatness is produced wholly by the surrounding fatty tissue. If the child becomes thinner (atrophy) the arch of the foot presents itself immediately after the disappearance of the fat (impression of the sole).

Conditions remain stationary during the period of infancy. Later on, with increasing corpulence the foot apparently again becomes more flat.

A child starts some kind of locomotion during the seventh and eighth months. It should normally be the kind of motion which in the history of mankind preceded the erect posture and gait.

Creeping. — Healthy children, when left to themselves, generally adopt this kind of locomotion. It should be encouraged by all means, because it meets the natural requirements and trains the bones, muscles, and joints to bear weight later on. Suppression of this period of creeping must be considered a severe educational mistake.

Where children are taught to stand on their feet too early the untrained muscles, bones, and ligaments yield to the overweight and deformities of the foot are produced, the marked degrees of which we term *flat-foot.*

The weight forces the astragalus forward and downward upon the oblique articulating surface of the os calcis, at the same time calling forth an outward rotation of the astragalus. This intended torsion is communicated to the other bones of the foot, resulting in a turning of

the foot outward. The inner border of the astragaloid trochlea endures more weight, the os calcis is turned outward, and we are face to face with a condition which we term pronated foot or flat-foot (see section on Flat-foot).

Even in a normal foot the period when a child begins to walk is a critical one. The arch of the foot is distinctly lowered during the first half of the second year. The head of the astragalus and the scaphoid bone force the fatty tissue downward (physiological prominence). With the beginning of the third year the foot becomes strong enough to eliminate the lowering of the arch. Because the period of the first corpulence passes at this time, the foot begins to appear more hollow and the impressions of the sole resemble more and more those of adults.

Moreover, it must be stated that in children whose feet are pressed into shoes at an early date the development of the feet is much slower than in barefooted children.

If the commencement of locomotion in a normally built bone spelt danger to the further development of the foot, how much more dangerous must it be when the osseous and ligamentous structures yield, and when a disproportion exists between the weight to be transferred and the strength of the lower limbs to support such weight?

In overfed, heavy children who are immediately taught to stand on their legs, rachitic tendencies are not even necessary to produce deformities of the feet. Flat-foot, the deformity brought on by overweight, is soon noticeable (in an increased measure if complicated by rachitis).

(a) *Flat-foot (Pes valgus)*

The **pathological anatomy** of the bones and joints is just opposite to that of club-foot. The foot appears to be turned outward below the ankle and the axis of the lower leg presents an outward deviation in the plane of the ankle. The internal ankle projects considerably; the arch of the foot is not alone lowered, but in severe cases even appears to be convex, the bulging resulting from constant lowering and outward turning of the head of the astragalus and scaphoid bones. The inner border of the foot is apparently much longer than the outer.

Symptoms. — The most important symptom is undoubtedly the deviation of the axis of the lower leg (pronation and abduction of the foot). The evidence derived from an impression of the sole on blackened paper which is commonly employed in adults fails in children, on account of the above-mentioned reasons (fatty tissue). (See Pathology of the commencement of locomotion.)

The gait of such children is heavy. While in normal children the trotting gait soon gives way to the ordinary swing of the feet, children afflicted with pronating deformities continue to walk upon the entire

sole. The toes are markedly turned outward, the soles of the shoes are worn away on the inner border, and the children are quickly tired out, complaining of pains and discomfort and want to be carried continually.

The condition may become permanent in case the deformity remains untreated and the deforming factor active. The children grow up with their flat feet and complain less of pain as they become stronger, while the parents lament about their ungraceful gait and the rapid wearing out of shoes around the internal ankles.

However, such weak feet in early childhood are often the beginning of severe deformities later on, such as flat feet, which become quite painful when subjected to an increased strain during adolescence or deficiency of vitality after the fortieth year.

FIG. 105.

But even in a child "weak-foot" may develop into an actual flat-foot which may become a very painful affection.

Prophylaxis and Treatment.— The important question of prophylaxis may be settled by insisting upon the following demands:

1. The feet of small children must never be forced or pressed into shoes.

2. Creeping must be encouraged as much as possible. Infants should be placed on the stomach. Inquisitiveness and the desire of locomotion will soon induce the child to get accustomed to creeping.

3. Abnormal locomotion, such as sliding over the floor on the buttocks,

Mild flat-foot of the left leg. Severe flat-foot (pes valgus) of the right one. Also slight right genu valgum. Child three years old. The axis of the lower leg presents a marked outward deviation at the right ankle; also pronounced outward rotation of the foot.

develops when children are forced to assume a sitting posture at too early a date, the creeping period being suppressed.

4. The period of creeping must be changed spontaneously by the child into one of walking. Only when a child of its own accord attempts to stand up and walk ahead, holding to some surrounding object, should it be permitted to do so.

5. To force children to walk, either with the aid of a nurse or go-carts or walking apparatus, is absolutely objectionable. All such appliances and devices of any construction whatever are impracticable and unnatural. Hastening the commencement of locomotion increases the danger.

6. Children must not be taken on long walking trips where there is little or no opportunity for them to rest when overcome with fatigue.

7. Regarding the choice of shoes, sandals with free soles to allow of an unrestricted action of the toes are the best. The muscles of the toes are at the same time supporting muscles of the foot. The shoes must be made to order with broad soles for each foot separately.

Careful attention must also be directed to shoes in older children. A child must be given as much opportunity as possible to walk barefooted for the purpose of developing the muscles of the foot.

As soon as pronating deformities occur correction becomes necessary. In some cases, and especially in those accompanied by genu valgum, the patient seeks to compensate the deformity by walking with toes turned inward. It would thus be very wrong to attempt to change this rather ungraceful but certainly not dangerous attitude of the foot. It would only increase the main trouble.

The **treatment of genu valgum** is identical with that of flat-foot. By establishing an oblique supinating base for the feet, as mentioned above, the knees are forced apart and the faulty attitude of the joints of the foot is corrected.

For this purpose the inner side of the shoe must be raised about 1.5 cm. The ideal way to change the shape of the foot is to employ individually prepared celluloid supports (Lange) (Fig. 106).

A plaster cast of the unweighted foot is taken. The foot is held in pronated position with toes adducted during the application of the negative. The child is told to stand on the foot just before the plaster becomes firm or the foot is pressed against a board. Layers of celluloid mass, bandage of webbing and straps are applied over the positive. The layers are stiffened with steel wire and, according to Lange's suggestion, supports are prepared which retain the foot in any desired position. This cast surrounds the heel and gradually raises the inner arch of the foot, and a high border on the outer side prevents the foot slipping from the raised inner side and prohibits any abduction in Chopart's joint.

By the introduction of small wedges between the sole of the shoe and the plaster supports on the inner side, the cast may be supinated to any degree. The child is now placed with the cast on a hard table and the inner side raised until the deviation of the axis of the lower leg is not only corrected, but even overcorrected to a slight pes varus. Measurements for shoes are taken over these supports. The shoes will not appear to be exceptionally large if the supports are trimmed in a reasonable way. The moment the child walks with these shoes and supports, the foot is forced at each step into supination and adduction. After several months the overcorrection may gradually be abandoned and the foot under this treatment may be brought back to its normal shape.

All other purchasable and mechanically contrived braces and supporters do not answer the purpose at all, or at least not to this extent.

They may possibly — by the insertion of a pad of rubber, cork, or leather — prevent a further depression of the arch of a foot and alleviate the existing pains, but they certainly can never have as much influence upon a foot as a celluloid support in changing entirely the existing

FIG. 106.

Preparation and effect of the arch supporters made with celluloid and steel wire (Lange). $a\ a_1$, a strap is fastened with cords over the positive cast and covered with a mass of celluloid (made of celluloid dissolved in acetone); wires which have been bent to suit the arch of the foot are fastened over this covering with cords. The direction of the wires is shown in a_1. A new layer of the celluloid solution is applied over the wires. $b\ b_1$, a piece of webbing is now added above the layer of wires and covered with the last layer of celluloid. The negative is separated and trimmed, and the inner side is raised with wedges of cork or similar material. $c\ c_1$, shows the effect of the supporter upon the feet. Observe the axis of the lower leg.

deformity. Correction or overcorrection of the abduction of the heel and front part of the foot alone, in combination with a raising of the arch, may bring about a normal development in the growth of a diseased foot.

About the same measures are to be employed with older children. In weak ankles, weak feet and flat-foot, individually prepared supporters must be used.

It is unimportant what material is chosen. Celluloid and steel wire are the lightest and firmest. This simple technic enables the physician and patient to be independent of bandage makers and shoemakers. It is quite incomprehensible that some authors still persist in advocating the purchase of arch supporters by number.

In addition, much care must be given to the strengthening of the muscles of the foot. Walking barefooted, especially walking on the front part of the foot, grasping motions with the toes, exercises with foot weights to increase supination tend to strengthen the muscles. Growth and increase in strength are impeded by weakening the feet—wearing too narrow and pointed shoes and faulty and deficient use of the lower limbs.

The form of flat-foot (pes planus) which has been occasionally described in text-books, does not exist in reality except in small children when they make their first attempt at walking. In older children it is always combined with an outward deviation or pes valgus (Spitzy).

(b) *Deformities of the Toes*

The wearing of shoes whose manufacture is dictated by common sense (the so-called "American cut") prevents to a certainty all deformities of the foot and toes which are caused by too short or too narrow and pointed footwear. Although, as a rule, deformities only reach full development in adults, children must suffer in later years for the mistakes parents make at an earlier period.

The Claw-foot.—We sometimes observe in children a peculiar position of the toes, especially of the first phalanx, which resembles very much the condition in claw-hand. The arch is raised and the heads of the metatarsal bones project towards the sole and the third phalanges of the toes turn in like claws. This attitude is caused partly by too short shoes and partly by an affection of the interosseous muscles (manifest in nervous degeneration—see Paralysis of the ulnar nerve). Operations such as tenotomy of the plantar fascia or lengthening of the shortened tendons of the extensors are in my opinion of less benefit than a well-fitting brace to readjust the depressed row of metatarsal bones. The foot must be freed of shoes by the frequent use of sandals.

Hallux valgus is an outward deviation of the great toe, generally the result of wearing too pointed shoes. The big toe, which in children is turned inward, is pressed outward by the deflecting inner border of the shoe and separated more and more from the head of the metatarsal bone. The tendons of the flexor and extensor muscles are likewise

deflected.   In severe cases the deformity forces the great toe entirely outward and often above or beneath the other toes.   The head of the metatarsal bone projects inward and calloused skin is formed over the prominence as a result of pressure from the shoe.   Chilblains appear as a result of deficient blood supply.   The periosteum becomes thickened and produces exostosis, and a condition termed *bunion* results.

Prophylaxis is all that is necessary in children; good, well-fitting shoes with a straight inner border ("American cut") will certainly prevent deformities or correct them without the necessity of performing operations or wearing some kind of redressing apparatus.

Pressing the toes over one another in very pointed shoes produces often a flexion and contraction which is termed *Hammer-toe*.   The second toe being the longest is the one usually affected.   The end phalanx faces downward.   The second phalanx is deviated and presents a large corn on its dorsal surface.   The deformity may be acquired by wearing short and narrow shoes, but it also may be a congenital condition.   (Personal observation of a family, all the members of which, including even the smallest children, presented the same deformity of the second toe.)

In mild cases elevation of the downward bent distal end of the toe is sufficient by placing it on a bridge made of adhesive plaster which runs from one neighboring toe to the other.   If a correction is not perfected after two months a subcutaneous division of the flexor tendons is performed in the first interphalangeal joint, and if further necessary, the shortened capsule transversely divided.   The affected toe is firmly bandaged with a steel splint covered with felt, and thus kept in fixation for fourteen days.

SURGICAL INFECTIONS

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NATURE AND SYMPTOMS OF INFECTIONS

Poisons may enter the body through the skin or the mucous membranes (infection). These poisons are usually of bacterial origin, whilst the true poisons (bites of snakes and insects) play only a very minor rôle. As a rule, we find the most important cause of infection among the bacteria. They act either mechanically (obliterating the blood-vessels through their tremendous increase in numbers) or most frequently through the poisons they produce (toxins), which are secreted by the bacterial cell and which are peculiar to each species (specific). The bodies of the bacteria contain similar poisons which are freed by their disintegration (toxins). Some bacterial poisons destroy the red blood-corpuscles (hæmolysins), others again cause the red cells to conglomerate (agglutinins). When the bacteria enter the body they destroy some of its cells; the parts surrounding the port of entry make preparations to defend themselves through inflammation, the flow of blood in the neighboring blood-vessels is accelerated (active hyperæmia), the blood-vessels and capillaries are dilated, but owing to the damage suffered by the blood-vessels the blood current is soon retarded in the centre of the inflamed area (passive hyperæmia). The bacterial poisons attract the leucocytes (chemotaxis). These latter go to the walls of the blood-vessels and migrate through them, and at the same time considerable quantities of liquid will leak through the blood-vessels into the surrounding tissues (inflammatory infiltration, œdema); in the mean time the affected cells have been killed, partly through the action of the poison and partly through interference with their nutrition. The dead tissues are dissolved and segregated, and regeneration takes place from the healthy surroundings.

According to the greater or lesser rapidity with which these processes take place, they will be either acute or chronic in character; according

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to the condition of the exudate from the blood-vessels being serous, fibrinous, or consisting of pus-cells, we differentiate between serous, fibrinous, and purulent inflammations. These local symptoms are accompanied by general systemic symptoms. The protective powers of the body are awakened by the absorption of the bacterial poisons. In the blood we can observe the production of the protective apparatus with which we have been familiarized through the work of Ehrlich and Metschnikoff. The action of the bacterial poisons is neutralized and the bacteria themselves are killed by the formation of substances which dissolve the bacteria and antitoxins and through the coöperation of different substances (complement and amboceptor) which are either in solution in the blood or combined with its constituents. Through the formation of opsonins they lose their power of resistance against the leucocytes, which increase tremendously at the site of infection and arrive there by migration and take up the weakened bacteria and destroy them. These processes are accompanied by a rise in the body temperature—*fever*. This differs characteristically in the different kinds of infection. Its peculiar course, its high excursions and deep remissions, as well as the way in which it terminates, may be used as an aid in diagnosis.

If the system should not be able to localize the infection and to wall it off against the rest of the body, then the bacteria and toxins will inundate the body—*general infection*. The body tries to protect itself against this invasion by defensive measures which are accompanied by high fever; bodies which have been considerably weakened cannot put up a sufficient defence if the infection should be highly virulent, and they will soon succumb to the general poisoning (septicæmia of atrophic children without fever).

PYÆMIC INFECTION

The most important pus-producing bacteria — pyogenic microorganisms—are the following:

1. The *Staphylococcus group* (usually Staphylococcus pyogenes aureus, Fig. 107a, Plate 9). The masses of cocci are aggregated in the form of grapes, they are stained with basic aniline stains, not decolorized by Gram's method; on gelatine they grow either as small white dots or as gray membranes, they liquefy the gelatine giving it a yellow color; on agar they grow first as round white colonies which later on turn yellow, they do not liquefy agar; they render broth turbid.

They are extremely frequent and very resistant.

In the human body they are found in the recesses of the mucous membranes—in the mouth, the intestinal canal, and in all the cavities communicating with the outside world, in the nail-folds and in the

folds of the skin. They may remain entirely innocuous until an injury or a damage to the tissues admits them into the body proper. They differ in virulence and pathogeny, they are the causes of many infections of wounds, abscesses, suppurations of joints, osteomyelitides. Staphylococcus pyogenes albus and Staphylococcus pyogenes citreus are rarer varieties.

2. The *Streptococci* (Streptococcus pyogenes, Fig. 107b, Plate 9) are found in chains, they stain with aniline stains and with Gram's method, on gelatine they grow slowly without liquefying it, on agar and blood serum they form small translucent colonies which usually die in a few days; they render broth turbid.

These also are frequently found upon human beings and their surroundings (see Streptococcus enteritis of infants).

When they enter the body they cause malignant suppurations, especially after they have once passed through the human body.

White mice and rabbits are very susceptible to this form of infection, usually dying after a few days, frequently with the formation of numerous metastases. The different kinds of antisera (Marmorek, Tavel) are very uncertain in their action, because the pathogeny of the different species of streptococci varies for animals and humans (Lexer).

3. The *Diplococci pneumoniæ* (Frankel) (Fig. 107c, Plate 9) are closely related to the streptococci; they are usually found in pairs surrounded by a common capsule which is hard to stain; occasionally they may be found in chains. This diplococcus is the cause of fibrinous pneumonia; it is found in suppurations of serous cavities which it reaches through the blood current. These suppurations are not quite as malignant as those caused by streptococci. Under normal conditions it is found upon the mucous membrane of the oral and nasal cavities of many healthy people.

4. The *Bacillus pyocyaneus* is a small and very active rod which does not produce spores; it is stained with aniline dyes, decolorizes by the Gram method, liquefies gelatine, after growing in whitish colonies, which soon assume a bluish-green color and give off the typical odor of elder. Dressings soiled with the pus also give the peculiar color and odor.

It is a frequent inhabitant of the human skin; the suppurations produced by it are benign, but it is very resistant and it is very difficult to eliminate it from a wound. It affects especially open granulating wounds (burns) and causes profuse secretion which interferes with the healing process ; it is easily transmitted through the attendant. (Disinfection with formalin!)

5. The *Bacterium coli commune* (Escherich) (Fig. 107d, Plate 9). This species of bacterium is also of great importance in the surgery of childhood (Moro, Darmflora). A short motile rod which does not

PLATE 9.
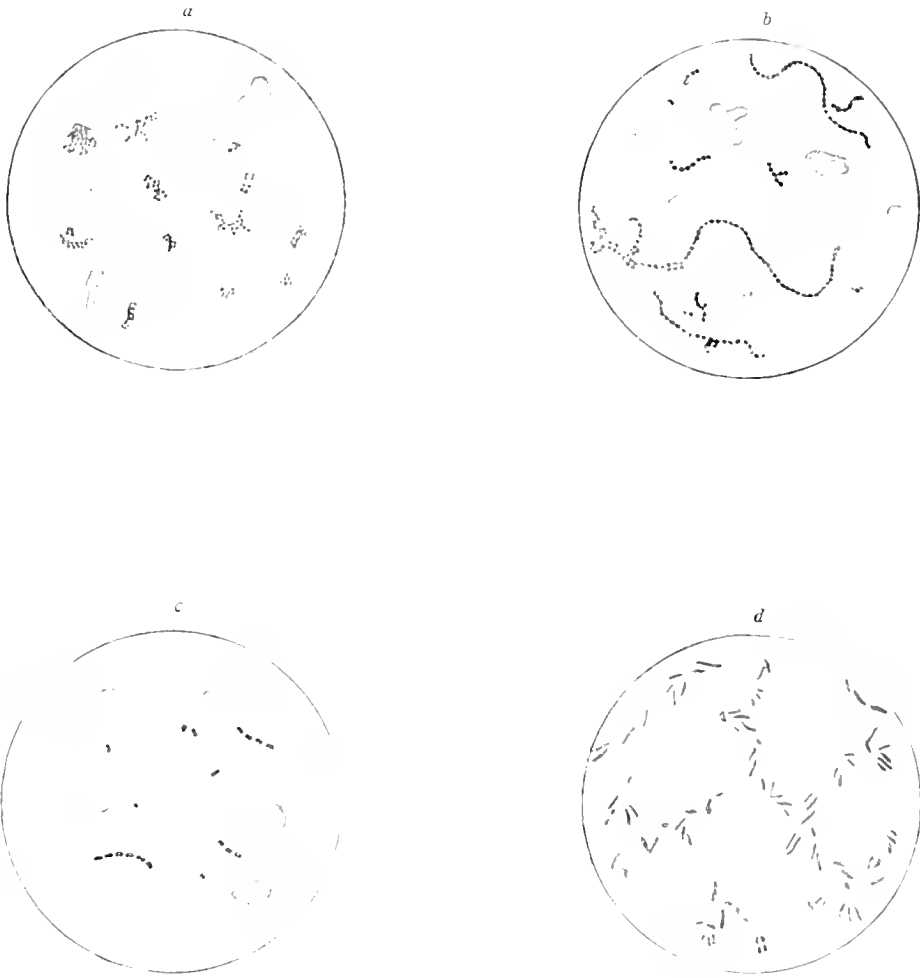
FIG. 107 — *a*, pus containing staphylococci. From a case of gonitis. *b*, pus containing streptococci. From a case of peritonitis. *c*, pus containing diplococci. From a case of pericarditis. *d*, pus containing colon bacilli. From a case of cystitis.

produce spores, stained with aniline dyes, decolorizes by Gram's method, grows on gelatine in stab cultures in the shape of a wire nail without liquefaction. It is the regular inhabitant of the intestine, but is also found on the skin and in the clothing. In injuries and disturbances of the intestinal wall it causes suppurations in the abdominal cavity, which differ according to the virulence but are better borne by the child's body than streptococcus infections.

The Reaction of the Child's Organism upon Suppurations.—From the short survey we have just given of the commonest sources of infection and of their usual habitat we readily understand how easily they may enter into the cellular structure of the body. Small breaks in the skin, as the hair follicles, suffice for their entrance; disturbances in the mucous membrane or thermic or mechanical irritation (refrigeration) reduce the resistance of the mucous membrane sufficiently to permit the transmigration of micro-organisms.

The mucous membranes on which they usually live have adapted themselves to their lodgers, and their plentiful blood-supply is without doubt an added means of protection, which is further aided by the secretion of mucus. Granulating wounds are also protected against bacterial invasion so long as they remain uninjured (Nötzel). Scratching and sloughing disturb the protective layer.

When the bacteria have once entered through a breach in the tissues then will follow that fight which we call inflammation, from the close observation of which Bier has evolved his ingenious method of treatment. We must never forget when we are treating an infectious process that the inflammation is nature's attempt at walling it in, that the fever is an indication of the fight, and that we are, as a rule, not justified in interfering except when specially indicated

We possess an excellent means of watching the general condition of the system in the temperature curve. Especially in the child's body will we observe that the reaction is a considerable one and may easily make us apprehensive; on the other hand, we must always remember that the child's heart is still sound and only rarely affected by chronic poisoning and that it will therefore usually surmount severe suppurations easier than the adult (purulent peritonitis, multiple suppuration of joints in infants). We must, however, guard against any extensive trauma and profound shock, as these may suddenly reduce the iife energy to its lowest ebb, owing to the ever-present danger of the lymphatic diathesis.

Thus we will observe that children do not stand relatively large wounds well, extensive opening of infected cavities filled with purulent exudate (pleurisy, peritonitis), nor a long-continued narcosis which might be required for the surgical measure.

Neither do children, especially small ones, stand considerable loss of liquid, be it blood or exudates of any considerable amount; they dry up, as we may say, under the hands of the physician (see Empyema).

I. THE PURULENT INFECTIONS OF THE SKIN AND THE SUBCUTANEOUS TISSUE

Infections of the skin, especially of the tender skin of the newborn or the infant, cause troublesome and extremely malignant affections.

(a) *Furuncle, Abscess, Phlegmon* (Galewsky, vol. iv).—It is generally the Staphylococcus pyogenes aureus that invades the skin and there causes necrosis of tissue either through the action of its virus or through interference with the nutrition. The invaded area is marked off by inflammation and the formation of pus, then partly breaks down and is finally eliminated through an opening in the thinned and ischæmic skin. Numberless germs in the pus flood the surrounding skin, where they find easy entrance, as they are now much more virulent because of their former residence in the human body.

It has not yet been determined how much of a rôle in this process is played by digestive disturbances or general infections, but we can easily understand that atrophic and badly nourished infants offer less resistance than strong and healthy ones, without our trying to explain this by the aid of other facts (intestinal infection).

Several furuncles or subcutaneous abscesses will run together and in their progress undermine the whole skin, lifting it off the subjacent fasciæ, often perforating in many places. On the skin of the back in infants we frequently observe these progressive processes.

The formation of furuncles usually starts from regions where the skin is most subject to injury, where it is chafed by the clothing and macerated by perspiration.

We differentiate between the *sebaceous furuncle* (folliculitis abscedens) and the *cellular furuncle,* which latter is very close to an abscess, according to the origin of the furunculosis from a folliculitis or from the tissues themselves (Galewsky). In infants the furunculosis starts, as a rule, either on the back, on the occiput or the buttocks and it spreads from here over the body, while in older children those regions are more often affected which are mostly subject to injuries like the hands and feet and the nape of the neck (collar-abscesses). The deeper the seat of infection and the more extensive, the closer it will resemble an abscess or phlegmon, which, however, do not differ materially.

The **general symptoms** increase with the size of the infected area.

The **prognosis** depends, naturally, largely upon the extent of the infection and upon the age of the child and its power of resistance. Even weakly children will survive a staphylococcus-furunculosis, while a

streptococcus-phlegmon in an infant will spread rapidly like an erisypelas and lead to a speedy death (sepsis). The result of an umbilical infection is similar, owing to the wide obsolete veins which favor its spreading through the system. But even smaller furuncles and subcutaneous abscesses may lead through a combination of unfavorable circumstances to a general systemic infection or at least to a spreading of the germs to other organs.

Treatment.—This should always be adapted to and limited by the condition of the child. Just as it may be unsurgical to treat an extensive phlegmon in an adult with small punctate incisions, so it would be a mistake to treat abscesses and furuncles with "wide and sufficient" incisions or to lower the child's vitality through frequent painful packing. In the furunculosis of children we have to evacuate the pus through

FIG. 108.

Folliculitis abscedens multiplex. Child of three months. Staphylococcus infection.

small punctate incisions without irritating the adjacent skin by strong antiseptics, but we must cover it before the operation with an indifferent salve through which we open the furuncle and then aspirate the pus with a small suction cup (Klapp). We must daily empty every newly-formed furuncle in this manner or those that have refilled. We also give the child a warm bath to which enough potassium permanganate has been added to make the water pink.

Otherwise we protect the skin as much as possible and wrap the child up warmly. All energetic interference is dangerous either because of the considerable loss of blood or because of opening new avenues for infection.

Squeezing or pressing the furuncles must be absolutely prohibited, because the natural wall is thus easily broken and a general infection may follow. The same may be done by packing larger abscesses because the gauze may easily cause a necrosis of the surrounding tissues.

The *treatment of abscesses* in children is similar. As soon as the abscess reaches the surface and fluctuates distinctly, under ethyl chloride anæsthesia and after first protecting the neighboring skin where it "points," we make an incision and then aspirate the pus, the examination of which will show which germ caused the infection. Packing is superfluous and very painful as well; should pus collect again it is an easy matter to reopen the incision with a probe until the core is entirely separated. This is surely less painful than repeated packing. We apply heat to favor the natural hyperæmia and to help the inflammation; ice-bags are a mistake, and are permissible only in those cases where the high tension of the tissues causes unbearable pain (tonsillar abscess) or in which we intend to make use of the therapeutic action of retarding the process (slower absorption of the virus in peritonitis).

This treatment with slight changes will suffice for larger abscesses and phlegmons as well. We aid the reactive inflammation by the application of heat (thermophores, poultices, warm fomentations); we do not make our incision too large, or at least not continuous; we avoid packing and syringing; in short, we refrain from anything which might injure the tissues.

If the discharge of pus should not be sufficiently free owing to the deep location of the abscess cavity (valvular closure of the edges of the wound), we can remedy this easily by the insertion of a permanent drainage tube of either glass or rubber.

Should the focus be on a limb we can use Bier's hyperæmia. We apply a circular elastic bandage as proximal as possible from the focus of infection and thus impede the return flow of blood through the cutaneous veins, while the arterial flow which is located in the centre of the limb is not interfered with, and we thus greatly augment the passive inflammatory hyperæmia and the exudation (inflammatory œdema) (Bier).

The constriction must not compress the pulse and the extremity must remain pink. After from six to twenty hours, according to the condition of the skin, the bandage is removed and the limb elevated, waiting until the œdema has disappeared before reapplying the bandage.

During this treatment the patient must remain in bed, on account of the fever.

(b) *Erysipelas* (Knöpfelmacher, vol. i).—This is an infection of the skin which is accompanied by a rapidly increasing redness, swelling, and high fever.

"For its causation are required, first, a highly virulent strain of streptococci, and, second, that the lymph spaces in the skin or mucous membrane be infected; the first local symptoms will appear one or two days later" (Lexer). At the point of injury (which cannot always be found, in the nose or in the pharynx) red spots will appear. These have

a sharp border, marking them from the surrounding skin, and they are slightly elevated; the wall-like border advances rapidly, especially where the skin is loosely attached. This is accompanied by chills and high fever, vomiting and drowsiness, and severe malaise; suppuration in subcutaneous tissue may accompany the process in the skin, and we may also observe pus blebs, acute glandular swellings, abscesses, and metastatic suppurations in other organs.

The **prognosis** is absolutely unfavorable in infants, but it gets better with each year.

The **treatment** is by no means successful. Mechanical walling off with strips of adhesive plaster has been tried (Wölfler), but without success. Disinfectants, alcohol compresses, 10 per cent. ichthyol ointment, only allay the pain. Antistreptococcus serum does not offer much hope of success, owing to the rapid course of the disease.

Pfaundler (personal communication to the author) has observed excellent results from painting with phenol-camphor twice daily. Judd recommends painting with pure carbolic acid until the skin is white, then washing with alcohol. [Credit should be given for this treatment to the late Seneca Powell.—THE TRANSLATOR.]

Treatment should be determined by the patient's general condition and should be symptomatic for the local affection.

II. THE PURULENT INFECTIONS OF THE MUCOUS MEMBRANES

The mucous membranes are also subject to the invasion of pyogenic germs. Acute inflammations either superficial or deep follow the infection. To the invasion of some of these germs the system responds by an increased secretion of mucus, of others by the formation of a fibrinous scab, of still others by a bloody-purulent exudate; the neighboring lymph-vessels and lymph-glands are always affected and form large abscesses near the site of infection, the symptomatology and treatment of which we give when speaking of the lymphatic apparatus.

III. PURULENT INFECTIONS OF THE LYMPHATIC APPARATUS (LYMPHADENITIS)

The infection travels through the neighboring lymph-vessels into the lymph-glands, which are really filters interposed in the lymph-channels, and is deposited there (lymphadenitis purulenta). The glands may be regarded as outposts which guard the parts of the body behind them against the advance of the virus. In the skin flaming red streaks mark the advance of the infection in the lymph-channels. As soon as the poison and the germs which produce it reach the glands they begin to swell and the lymphocytes increase in number, the glandular structures are filled with serous exudate, and the glands are extremely sensitive to motion and pressure.

If the lymphatic gland should not be able to withstand this attack, then it will itself succumb to the poison and become necrotic, the germs are thus themselves checked in their advance and the dying gland still fulfils its mission of protecting the body; the germs are later eliminated, together with the broken-down glandular substance.

The **treatment** is identical with that of deeper abscesses. In the simple form with painful swelling, rest and heat to produce hyperæmia are sufficient; the gland goes down, the swelling is "scattered."

If there is suppuration, the inflammatory focus is walled off against its surroundings; later this wall reaches the surface and becomes adherent; redness and fluctuation determine the time for surgical intervention, which consists in a puncture opening, aspiration and, in some cases, drainage.

Fig. 109.

Abscessus submentalis. Child of twenty-two months. Treatment, punctate incision from the chin, warm compresses, no packing. In the thin pus staphylococci and streptococci were found.

Larger incisions are justified only in deep phlegmons when the gravity of the general condition demands this. A "thorough cleaning out" of all infected glands means tearing down all the protective walls and therefore the grave danger of a general infection and an injury to the child's body which is hard for it to overcome.

The following purulent inflammations which start from the mucous membranes and travel into the adjoining lymph-spaces and lymph-glands are typical of childhood:

(a) *Suppuration of the Floor of the Mouth* (Moro, vol. iii) (Fig. 109).— This consists in a purulent inflammation which starts from the mucosa of the floor of the mouth. The infection attacks the lymphatic apparatus of the chin; the swelling makes the submental region protrude and the tongue is lifted up and frequently swollen as well. **Treatment** consists in timely incision either through the mouth or from the chin, and warm moist compresses.

(b) *Retropharyngeal Abscess* (Finkelstein, vol. iii).—This usually starts from the mucous membrane and the lymphatic apparatus of the pharyngeal wall, or sometimes from the tonsillar tissue as a tonsillar or a retrotonsillar abscess.

The abscess may spread along the pharyngeal wall, pushing it forward, and may interfere with respiration and swallowing, either through its own volume or through the collateral œdema. To make

breathing easier the mouth is kept open. These difficulties may increase to such an extent as to cause death from suffocation; in favorable cases the abscess will break and the pus is discharged in streams from the mouth and nose.

This process may be caused either by the well-known pus-bacteria or by a local tuberculous focus or one at a distance from which the pus has descended to this region.

The diagnosis is easy from the pronounced symptoms. Inspection of the neck and pharynx and palpating with the finger will reveal the baggy swelling of the pharyngeal wall. Whenever a child has difficulty in breathing we should always think of this affection.

Treatment consists in opening the abscess. All except the point of a knife is covered with adhesive plaster and it is then introduced through the mouth upon the guiding finger and the abscess opened, guarding, however, against injuring any other organs (especially in struggling children). As soon as the abscess is opened the child should be quickly inverted so that it cannot swallow the pus or aspirate it into the respiratory tract.

A second incision at the edge of the sternomastoid muscle is necessary only in the rare cases in which a large abscess is about to break through the outer skin.

(c) *Acute Swellings of the Lymph-glands of the Neck* (Lymphadenitis acuta) (Finkelstein, vol. iii) should in the first place be handled etiologically. They belong regionally to affections of the scalp (eczema, impetigo, pediculi), the ear (otitis media, discharge from the ear), the oral cavity (teeth), or the pharyngeal or nasal cavities (catarrh, angina).

We first remove thoroughly the respective cause and then treat the glands according to the conservative surgical rules which we have given above and which insure healing *without* consequent deforming scars; this is especially important in this region of the body, as scars might later cause the patient to be suspected of a healed tuberculosis (scrofulosis). Lymphadenitides in other parts of the body (groins or axillae) should never be treated radically; the application of heat and punctate incisions will usually suffice, especially when no disquieting general symptoms arise. In deep lymphatic abscesses permanent drainage is used and they are never packed.

Tuberculous Lymphadenitis (see page 208).

The pharyngeal mucosa responds to chronic irritations with hyperplasia, especially in lymphatic diathesis. (See Finkelstein, Hyperplasia of the Faucial and Pharyngeal Tonsils, vol. iii).

If the adenoid growth should narrow the passage it should be removed by operation, adenotomy either with Gottstein's curette or with forceps; the instrument is introduced behind the velum and the

hyperplastic tissue is cut off; it is of the greatest importance to remove
all loose remnants, because they might cause a serious late hemorrhage.
(After having performed hundreds of adenotomies the author considers
narcosis superfluous.)

The faucial tonsils, when excessively large, are removed with a
tonsillotome (Fahnenstock's or Matthieu's). This operation can be
done in the physician's office, as the bleeding is inconsiderable and will
stop soon. Dusty air as well as hard and hot foods should be avoided
for a few days.

IV. THE PYÆMIC AFFECTIONS OF THE BLOOD-VESSELS (ARTERITIS, PHLEBITIS)

By this we understand that the purulent infection has spread to the
blood-vessels. It is found in children as an accompaniment of larger
septic processes.

Purulent thrombophlebitis of the umbilical vessels in the newborn
plays a special rôle; the infection proceeds along them to the peritoneum
and the liver, causing metastatic abscesses and general infections. (See
Knöpfelmacher, Diseases of the Newborn, vol. ii.)

The only hope of improving the unfavorable prognosis to some
extent would be to cut down at once upon the infected vessels and
remove them, but this procedure is usually done too late or it may open
the road to further infection.

V. THE PYÆMIC AFFECTIONS OF THE BONES (OSTEOMYELITIS)

Etiology and Pathologic Anatomy.—The bones are infected either
from an infection in the neighboring tissues or, far more frequently,
through the blood current (hæmatogenous infection), osteomyelitis after
croupous pneumonia (Feer, vol. iii).

The inflammation usually begins in the bone-marrow, where the
germs circulating in the blood are deposited and destroyed by the
bactericidal substances in the leucocytes (Wassermann).

Should the power of resistance of the bone-marrow be lessened
(trauma) or the germs be highly virulent, then the bacteria will be vic-
torious, producing purulent inflammation and at the same time poison-
ing and killing the marrow cells. In some rare cases this inflammation
may be caused by bacterial thrombi which are caught in the fine terminal
arteries of the bone near the epiphyses (Fig. 110, Plate 10). Only very
rarely does the infection enter from without through the periosteum.

The suppuration always proceeds through the Haversian canals
and reaching the periosteum causes a periostitis which raises it from the
bone (Fig. 111, Plate 10). The bone being bathed in pus on all sides
succumbs to necrosis, and the size of the necrotic piece varies according

PLATE 10.

FIG. 110a.

FIG. 111.

FIG. 110b.

FIG. 112b.

FIG. 110.—Extensive osteomyelitis of the femur (streptococcus). Boy of eight years. Disease beginning with high fever. Duration fourteen days, death.

In a large abscess in the bone-marrow was found the sequestrum (Fig 110b). Furthermore, multiple abscesses in the proximal metaphysis and also in the distal epiphysis rupture into the knee-joint at c.

FIG. 111.—Osteomyelitis of femur (staphylococcus). Girl of four years. Duration of disease before admission to hospital, three weeks.

Double contour clearly visible (but of the bone only, contour of skin not changed), medially from the diaphysis a large subperiosteal abscess.

FIG. 112b —Skiagraph to Fig 112a Osteomyelitis of the radius The thickened bone surrounds as an involucrum the lower metaphysis of the radius. At operation multiple marrow abscesses were found (diplococcus); the sequestrum was broken into many pieces.

to the extent with which nutrition is interfered with and may at times comprise the whole of the diaphysis. A layer of granulations forms at the border between the healthy and the diseased bone which gradually separates them, and which attempts to dissolve this "sequestrum," eroding it on all sides (Fig. 110b, Plate 10).

At the same time reparative processes will take place as in all inflammations; the periosteum forms new bone in excess which surrounds the sequestrum as an "involucrum," it is perforated by many cloacæ for the discharge of the pus, and it slowly solidifies from a pasty to a solid and firm plate.

The pus burrows through the soft parts to the surface, causing multiple fistulæ. Even large sequestra may be removed in the course of some years through the dissolving action of the granulation tissue and the process may heal spontaneously, provided, however, that the patient does not die in the meantime from the severity of the disease or from the long-continued suppuration (amyloid disease).

The disease is most frequent in the second stage of childhood, and it is observed oftener in boys than in girls, a fact which may depend upon the chances of injury; it is, however, by no means rare in infancy (Mohr, Broca).

The reason why the youthful bone is oftener affected may be found in its vascularity and in the abundance of cells of the bone-marrow in comparison to the fatty marrow of the adult (Lexer).

The long bones are the favorite sites of the disease; first in order is the lower metaphysis of the femur, then the upper end of the tibia, more rarely the humerus, the lower ends of the bones of the arm and leg, and the ribs. The short small bones, which are more subject to tuberculosis (vertebræ, sacrum, phalanges), are only exceptionally affected.

The **symptoms and course** are characteristic. A healthy child is taken ill suddenly with high fever and pain in the affected bone; in some cases a pneumonia or pleurisy may have preceded. Through the swollen soft parts we can palpate distinctly the thickened bone, the superficial veins appear ditated, the skin feels hot, the regional lymph-nodes are enlarged and painful.

The X-ray photograph will show a peculiar double contour around the affected bone after a very few days, due to the raised-off periosteum and the newly-formed bone arising from this (Fig. 111 and Fig. 112b, Plate 10). When we cut down upon the summit of the swelling and work through the soft parts, which are infiltrated with serum down to the bone, we find pus either under or above the periosteum and under this the white necrotic bone.

In the bone-marrow itself we find larger foci (marrow-phlegmon) and small disseminated foci near the epiphyseal line. These latter may

either break through the epiphysis or may cause separation of the epiphysis, or they may finally destroy the epiphysis and invade and infect the joint. The infectious material may likewise be carried through the blood into the other bones (multiple purulent osteomyelitis).

The infection of neighboring joints may either come from perforation (Fig. 110c) or from metastasis, but it may arise through close proximity through the action of toxins or as a collateral œdema (serous exudate).

All these complications mean a considerable aggravation of the process, as they indicate a spreading of the infection, which terminates fatally if it is allowed to progress. Bacteria circulate in the blood during the acute stage (Lexer, Garré).

The **diagnosis** is difficult only when large abscesses are situated close to the bone. Whenever we can separate these from the bone or when

Fig. 112a.

Osteomyelitis of the radius. Boy of four years. In the pus diplococci. Duration, three weeks; cured by sequestrotomy and ten weeks of after-treatment (excepting a slight stiffness of the wrist). See Skiagram 110b, Plate 10, of the same arm.

on incision we find the periosteum closely adherent to the bone, then we may regard the latter as healthy. The radiograph is of the greatest importance for differentiation (Fig. 111 and Fig. 112b, Plate 10).

For the diagnosis from caries see "Tuberculosis of the Bones."

Treatment.—When the nature of the trouble has been determined it is imperative to open the bone-abscess at once to give the pus a means of exit before further destruction can take place. Under Esmarch's constriction and avoiding carefully all tendons, blood-vessels and nerves, we work down to the bone, divide the periosteum and chisel a channel into the bone as far as the suppurative infiltration of the marrow extends; but in doing this we must refrain from further lifting off the periosteum and from all curetting. The purulent masses are removed by careful wiping and the cavity of the bone is drained.

The chronic stage follows in which the process progresses to the new formation of bone, building up of the involucrum, and demarcation and

separation of the sequestrum. Examination with the probe and radiograph will tell us the right times (usually after several months) when the sequestrum is loose and when it may be removed through a wide opening which we chisel into the involucrum. Even those cases which are more chronic from the beginning and those which we do not see until they are in the chronic stage are not subjected to the radical operation until the sequestrum is entirely loosened and the involucrum fully formed.

After removing the sequestrum the cavity is cleansed, the sharp spicula of bone are removed and the cavity made as shallow as possible. The cavity in the bone heals by granulation and this may be aided by skin grafting (turning in flaps of skin). All attempts at reducing the bone-cavity at once by osteoplastic measures (according to Lücke, Ollier, and Bier) or by putting in an iodoform filling according to v. Mosetig-Moorhof frequently fail, owing to the persisting virulence of the germs, which do not yet permit of a primary closure.

Shortening of the affected bone or disturbances in its growth are frequent sequelæ which demand correction after the primary process has fully run its course. Then we will be able to make use of the involucrum as a substitute for the destroyed bone, especially if we avoid all rough handling, since it is very easily fractured. Primary subperiosteal resection of the diaphysis has now been given up quite generally, because the formation of bone may fail even when the resection has been done subperiosteally, and also because even an extensive resection does not guarantee a cessation of the disease, but may even open new roads for infection (Smoler).

In cases in which an early resection is demanded before the involucrum may be used as a substitute, owing either to the poor general condition of the patient or to threatening amyloid disease, the dead bone is removed subperiosteally and a prosthesis substituted for it at once, made either of aluminum or tin. The shape is determined and the prosthesis made from a plaster cast of another bone of equal size before the operation and minor changes are made with a file. This immediate prosthesis prevents the retraction of the soft parts, which would otherwise surely take place during the healing of the purulent process.

Only after suppuration has ceased entirely may a permanent osteoplastic cure be attempted by grafting either free pieces of bone or other materials.

In the French literature we frequently meet with the interpretation of those frequent pains in the bones observed in children during the periods of their most rapid growth as a passing osteomyelitis (Poncet, Comby); but scientific proof of this explanation is still lacking, although we cannot deny that at these times infections of the bones, which are subdued by the protective apparatus without leaving any bad effects,

may be quite frequent (osteomyelite de croissance); also the pains and difficulties from insufficiency in the rapidly growing bones of children with a rheumatic diathesis after overexertion ("Arthritisme") are frequently due to passing softening of the bones (see Genu valgum; Coxa vara adolescentium).

VI. THE PYÆMIC AFFECTIONS OF THE JOINTS

Etiology and Course.—As we have mentioned above, infections of the joints may arise from contiguity, as well as from hæmatogenous metastases. Exudations into the joints are a frequent accompaniment not only of purulent processes in other organs, but also of many infectious diseases (measles, scarlatina, gonorrhœa, influenza); purulent inflammations are by no means rarely observed in children to be caused by staphylococci and streptococci, also often by pneumococci (see Bursitis pneumococcica, Kaumheimer).

A close network of blood-vessels and capillaries is situated under the innermost layer of the synovial membrane and these undoubtedly favor the transmission of germs. According to the virulence, kind and amount of immigrated germs the synovia will respond to the stimulus of the virus by the copious exudation of a serous or cellular-purulent liquid which fills the joint and distends it in all directions.

The normal contour of the joint disappears and we observe the picture of the distended capsule. The bones forming the joint are placed in that particular position in which it is easiest for the muscles to retain their equilibrium and at the same time to keep the joint as quiet as possible, because every movement hurts (position of pain); naturally the joint will now return to that embryonal position in which all parts of its capsule are equally distended while its muscles are in equilibrium (flexion in hip and knee-joints).

These exudates are accompanied by much fever, which is especially high in cases of purulent inflammation.

The serous exudate usually heals entirely (absorption) while the purulent inflammation leads often to extensive destruction in the joint, roughening of the surface, loosening of the cartilages, adhesions of the folds of the capsule, so that a destroyed and disabled joint may remain after the healing of the process. This disturbance will be still severer in cases in which the exudate has separated the components of the joint and in which the destruction of the ligamentous apparatus has permitted luxation to take place.

In childhood we are especially interested in the frequent *multiple infectious arthritis of infancy.*

The Staphylococcus pyogenes aureus and the Diplococcus gonorrhœæ are the germs mostly found, though a streptococcus may be the

cause in some rare cases. These affections are observed after diseases of the respiratory organs, after blennorrhœa of the vulva as well as of the eyes (Hutan), but frequently also without any recognizable port of entry.

Quite often the infection will originate from small intracapsular osteomyelitic foci (Broca, Mohr) situated in the epiphyses near the joints (A. Berg, Fröhlich) (Fig. 110c). In the hip-joint especially (Bruns, Müller) suppurations will produce a malposition of the bones which may

Fig. 113.

Coxitis purulenta (diplococci). Child of three years. Large abscesses under the skin, which have broken through the capsule and fluctuate. Treatment: punctate incisions, aspiration, drainage. Result: fixed luxation of the hip-joint, which was corrected after one and one-half years, leaving slight stiffness.

in later life appear as a congenital luxation (Drehmann). The author has personally observed thirteen such cases of infantile joint-suppurations, two of which left a luxation of the hip-joint. The large joints are mostly affected (hip, knee, shoulder), the small ones less often. Older children show these metastatic suppurative arthrites after scarlatina or accompanying an otitis media.

Treatment must always consider the function of the joints and the age of the child. In the arthritis of infancy the author strongly condemns any wide opening of the joint.

Should exploratory aspiration show the presence of diplococci or staphylococci, then repeated aspiration without flushing with irritating liquids will often suffice to bring about recovery. If this should not be sufficient or should we find streptococci, then we make a small incision (not more than 1 cm.) and aspirate the joint with cups (Klapp).

In refractory cases with recurrences we insert a glass drainage tube.

We should *never* pack the joint, because in doing this we severely injure and disable the serosa.

The **prognosis** of streptococcus infections is much more unfavorable. In all others we can by these means stay the process, and we usually succeed in retaining a useful joint. In one case of postscarlatinal affection of both hip-joints treated by this method one side healed entirely, while the other remained somewhat stiff owing to destruction of bone.

It is advisable even in older children not to sacrifice the function of the joint by adopting early radical operation, although we understand that as soon as the general condition assumes a grave aspect we must attempt to save the patient's life by wide incision, but in infants we refrain from this for exactly the same reason.

Postural **treatment** of the joint is of great importance in all such cases. This has for its object to fix the joint in the position that will insure the least loss of function in case the joint should remain stiff (fixation with plaster splints).

Chronic diseases of the joints occur similarly in the course of infectious diseases (influenza, acute articular rheumatism, measles), and in these cases bacteria have been found in the exudate and in the synovial tissue (Schüller, Spitzy), though the body then comes out victorious; but even in these chronic processes the joint may easily lose some of its functions owing to the formation of connective tissue, to scars and to other degenerative as well as regenerative processes.

VII. THE PYÆMIC AFFECTIONS OF THE TENDON-SHEATHS AND BURSÆ

These are not of the same importance in children as they are in adults, because in later life they may often be caused by the occupation. But the lining of the tendon-sheaths and the bursæ near the joints may be infected through metastasis the same as the synovia, even without any affection of the joint itself. Kaumheimer reports that he has observed three cases of para-articular pneumococcus infection in early childhood. Here again I must mention the ingenious method of Bier— small punctate incisions and aspiration of the pus through these. Wide opening and packing with gauze are contraindicated, nor must we apply bandages which will cause stiff fixation (necrosis of tendons, adhesions).

SURGICAL TUBERCULOSIS

The tuberculous infection is caused by the tubercle bacillus (Robert Koch).

This discovery has enabled us to classify a considerable number of affections under a single head, and the improved methods of examination have aided us in recognizing the cause of numerous surgical diseases of the bones and joints which we used to regard as separate diseases. We have thus not only advanced our knowledge of these affections, but have also materially furthered their treatment by recognizing their connection with the general affection. For the description of the biology

FIG. 114.
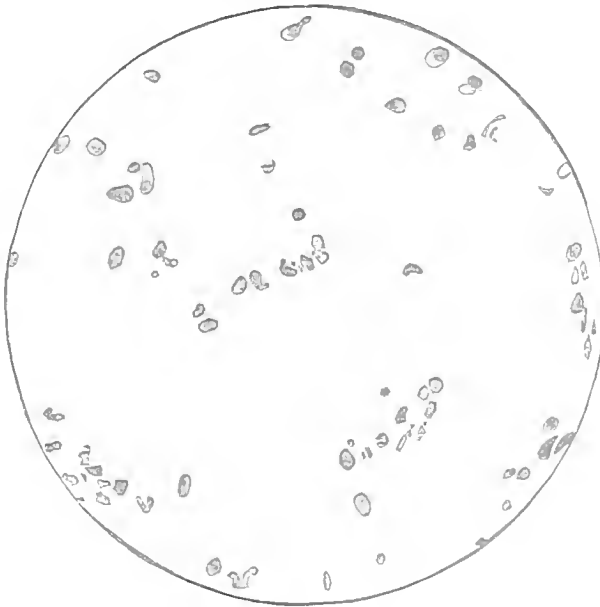
Lung tissue flooded with innumerable tubercle bacilli.

of the tubercle bacillus, the mode of infection, and the pathologic anatomy of the initial lesions, we refer to Schlossmann (Tuberculosis, vol. ii).

All the characteristics of tubercular inflammation which we know from the study of the tuberculosis of the lung (Fig. 114) are also found in those diseases which we comprise by the term surgical tuberculosis, though we naturally find some differences according to their location and to the nature of the affected tissue. The rapid growth of the tubercles, their lack of blood-vessels, their speedy breaking down, the exuberant granulations testify to a low power of resistance of the newly-formed tissue. Nature attempts to wall off the process against the advancing poison by calling to her aid tremendous numbers of leucocytes and by the throwing out of granulation tissue, but this latter crumbles down

easily and the destruction can be checked only with great difficulty. The caseous tubercles liquefy in their centre, are filled with purulent material, and several of these tubercles may run together, thus forming a cavernous abscess filled with thin pus containing only a very few bacteria.

The formation of these abscesses progresses only very gradually and with slight general symptoms (*cold abscess*) because the abscess is only the result of a slow death of the tissues and not the result of a victorious fight by which the infectious focus is strangled and expelled. In favorable cases scar-tissue will be formed from the granulations, but here also we observe the same weakness against the invaders. Quite frequently these cannot be killed and absorbed; the focus is walled in and encapsulated, and thus the dangerous germs may remain alive for years inside the healthy body.

We consider under surgical tuberculosis the affections of the lymph-vessels, the lymph-nodes, the muscles, bones and joints.

I. TUBERCULOSIS OF THE LYMPH-PASSAGES

The germs migrate from the adjacent mucous membranes of the digestive and respiratory passages into the lymph-spaces, while the lymph-vessels proper are only slightly irritated and rarely show the typical formation of nodules. Only in the lymph-vessels of the skin and the subcutaneous tissue do we at times observe an accumulation of nodules, which we call a tubercular infiltration of the skin (scrofuloderma) (see C. Leiner, vol. iv).

The filter-stations of the lymphatic apparatus, viz., the lymph-nodes, are, however, a favorite seat of the disease.

Tuberculous Affection of the Lymph-nodes (Lymphadenitis tuberculosa)

This is one of the most frequent affections in children. A large number of the tubercle bacilli which circulate in the blood and the lymph are deposited in the nodes just as in other infections. Once a group of organs has been infected the respective regional lymph-nodes will suffer first. They enlarge, typical tubercles are formed, and these break down in the centre and form abscesses. The lymph-gland is now pierced by abscesses and cavities until it is finally one abscess surrounded by the thickened glandular capsule. This latter is slowly absorbed and perforated and the pus infects the neighboring tissues and gradually works its way through to the surface. The walling off against the healthy tissue is not as intensive as in pyæmic infection, and, as the pus itself is not highly infectious, containing only very few bacteria, the whole process is a lingering one.

The skin is pushed out tightly when the pus reaches it and then shows increasing redness and the signs of perforation.

In some cases the cheesy nodes will become encapsulated, and calcification sets in, but they will harbor infectious material for a long time.

Tuberculosis of the glands may be observed in children either spread all over the body (polyadenitis) or confined to certain regions (bronchial, cervical, mesenteric, inguinal, axillary glands).

For us the most important is *tuberculosis of the cervical lymph-nodes*, which appears to be a primary affection, though it is in all probability secondary, as the glands are located close to the mucous membranes at the entrance to the respiratory and digestive tracts (Fig. 115).

We find nodular glandular tumors along the large blood-vessels in the neck, in front and behind the sternomastoid muscle downward into the clavicular fossa and forward to the chin, which give to the neck and face of the children such an ugly appearance that this, together with the catarrh of the mucosæ, has led to the adoption of the term scrofulosis.

These glandular swellings may disappear when the process runs its course in the glandular tissue itself (*restitutio ad integrum*). They may become indurated when the process is encapsulated in the glandular tissue itself, or they may caseate, suppurate and break through to the surface, and thus cause disfiguring fistulæ.

The glands are usually not tender, they are well defined, the single ones either round or oval,

FIG. 115.

Tuberculous lymphadenitis of the neck. Child of three years. Caseous and suppurating glands in the neck forming a fluctuating tumor. Treatment, incision and aspiration. The cold abscess in the lymph channels on both thighs shows the general infection of the body. Von Pirquet test positive.

differing in size and in consistency according to the degree of the changes.

Differential Diagnosis.—They differ from the *acute glandular swellings* by their course, the lack of tenderness in the beginning and the slight reaction in the neighboring tissues.

We can differentiate these from *lymphosarcoma* because they can be moved upon the underlying tissues and upon each other. The

sarcoma grows through its capsule and makes a compact mass of the glands and the surrounding tissues.

The diagnosis of *leukæmic glands* is made from the examination of the blood.

Pseudoleukæmic glands are the most difficult to differentiate, though the absence of scrofulous symptoms in pseudoleukæmic lymphoma will be of assistance, and finally the excision of a piece of gland, its microscopical examination, and animal experimentation (intraperitoneal injection of glandular detritus into guinea-pigs) will decide the diagnosis.

The **treatment** of this affection has undergone many changes in the course of years. The public learned conservative treatment from ancient medicine and they continue to favor it. It was known that the tumors would often disappear when the children began to look better. Larger glands were treated with heat (poulticing), under which some "were dissolved," others formed abscesses, and a few only remained "indurated." The results were frequently persistent fistulæ and disfiguring scars in the most conspicuous region of the neck.

When the antiseptic and aseptic era arrived the glandular tumors were doomed to the knife. Surgeons quite generally, including the author, made "thorough" extirpation through incisions along the sternomastoid or, according to Kocher, through incisions extending from the mastoid to the cornu of the hyoid bone. By avoiding the blood-vessels and working with blunt instruments it is possible to dig out the glands the same way as a potato is dug out of the ground. The small and numerous glands around the blood-vessels gave the surgeon much concern. Long incisions were not exactly things of beauty, especially when healing was interfered with by the bursting of suppurating glands, in which cases we got both long scars and fistulæ. Dollinger tried to improve the cosmetic effect by making his incision at the border of the scalp, but as this made the technic very difficult he found only few imitators.

These patients who had undergone a "radical" operation were apt to return the following winter or spring with "new" glandular tumors, and very few could be persuaded to undergo another "radical" operation, whilst the large majority were satisfied to have the cheesy glands scraped out and to have the pus let out.

The foregoing was the typical treatment of tuberculous lymphnodes up to a few years ago; these cases were the bugbear of the surgeons in children's hospitals. We have recently learned to improve upon this method (Bier). The author no longer operates on tubercular glands in children and considers total extirpation an unphysiologic procedure. The treatment should first of all be general, against the scrofulosis. It is unnecessary to treat irrelevant parts of a disease when recurrences are sure to occur.

The single glands are sucked into cups and are thus made highly hyperæmic. We apply the cups for five minutes and leave them off for the next five minutes. This is done several times daily. After school the children come to the out-patient's department and remain for the treatment for one hour. At home heat is applied (Fig. 116).

Time is not of great importance in children. Some of the glands disappear under the hyperæmic treatment, but most of them suppurate; as soon as fluctuation is present we make a small incision before the skin has time to become necrotic in order to avoid ugly scars.

The contents are aspirated through the opening in one or more sittings, and the application of heat is continued.

Fig. 116.

Lymphadenitis of neck with cups applied (Klapp). Girl of eleven years. Multiple glandular swellings for the last three years, for which she has been operated on repeatedly. Only the fluctuating abscesses were now opened. Otherwise treatment solely with cups.

No packing is necessary, but a drainage tube may be inserted in deep abscesses. Should a portion of the gland remain or fistulæ form we treat these also with cups and heat. The hygienic conditions should be improved if possible,—fresh air, plenty of sunlight, floating hospital, etc.; but never place these children in hospital wards.

The advantages of this treatment consist in the improved results, but not in shortening the time of treatment. Small and scarcely noticeable scars and the possibility of managing these cases in the policlinic, thus relieving the hospital wards of this class of unpromising cases, are advantages gained by these methods. Up to 1904, 100 out of a total of 500 operations annually in the author's service were for the removal

and scraping out of glands. In the last four years out of a total of 3000 operations not more than three were for the removal of glands.

With this treatment we imitate Nature and adapt our measures to the general condition and function of the glands. It is surely better for the child than total extirpation, which is still advocated in some recent publications.

We do not want to be misunderstood, for occasionally a refractory indurated gland in an older child may have to be removed. But then this should be done under strict cosmetic rules and without opening the gland if possible; any scraping or curetting must be avoided, because it simply offers a chance to spread the disease anew.

We have not seen any beneficial results from the medicinal treatment, iodine, and ointments of all kinds. At most they may aid in intelligent general treatment.

II. TUBERCULOSIS OF THE BONES

(See Schlossmann, Tuberculosis, vol. ii.)

Etiology and Pathology. —Infection is usually carried by the blood-current as in pyæmic affections. The primary seat of infection is not the marrow but the osseous tissue and the fine terminal arteries near the epiphysis, where clusters of bacteria are held up and begin their work of destruction. The fine branches in the zone of growth explain why this is the most favored site for this form of infection in the long bones. In the small bones the artery divides at once into numerous small branches so that foci may be very generally established (Lexer).

Tuberculosis of the bones is always secondary to a primary focus which may quite often be far away (bronchial glands, bronchial mucosa, etc.).

An injury may be the exciting cause, as it lowers the vitality of the tissues to such an extent that an invading infection cannot be resisted as in full health.

The disease progresses through blocking the arteries and the spread of the nodules in the poorly nourished regions. The masses of granulations dissolve the bone and bone cavities are formed which are filled with cheesy pus (caries) (Fig. 119, Plate 11). In some cases part of a bone will die from lack of nourishment and will become separated from the healthy tissue as a sequestrum and will be found lying in a bone cavity surrounded by pus and granulations (necrosis). In the epiphyses the foci are usually wedge-shaped, corresponding to the course of the branches of the blood-vessels.

In the meantime the tissue shows a reaction by attempting to wall off the disease and to form an involucrum. Periosteal excrescences must be regarded as reparative processes, which will form swellings especially on the small long bones.

PLATE 11.

Fig. 117. —Multiple spina ventosa on both hands of a child of three years. Swelling of the bones with pus cavities.

Fig. 119 — Tuberculosis of the calcaneus. Child of seven years. With V. Mosetig iodoform filling.
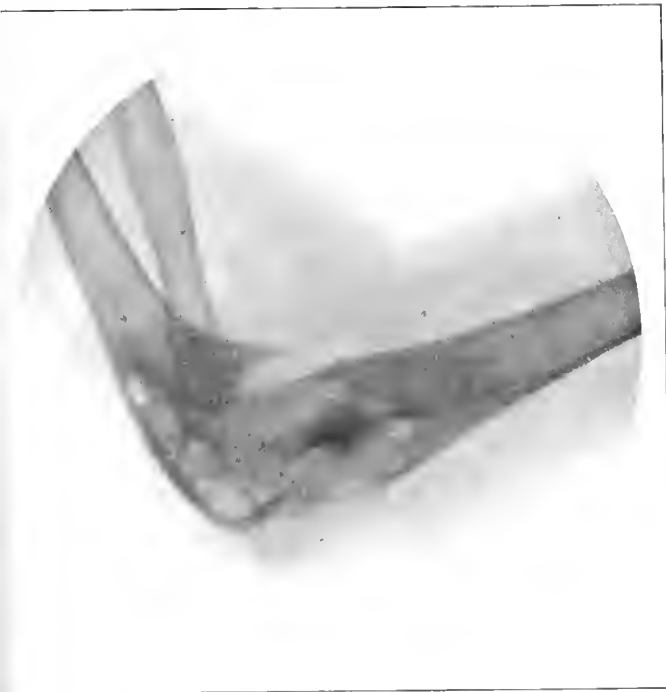
Fig. 118.— Tuberculosis of the elbow-joint, radiograph of Fig. 122. The lower end of the humerus is almost entirely destroyed, little reaction, no contours of the periosteum, extensive foci in the olecranon

While we find wedge-shaped foci near the epiphyses of the large tubular bones (Fig. 118, Plate 11), the arrangement of the blood-vessels in the short bones will favor a more profuse process which will destroy the bone from within and at the same time regenerative processes will take place in the periosteum with the formation of new bone tissue (spina ventosa) (Fig. 117, Plate 11).

Differences occur according to the situation and nature of the affected tissue. When near a joint there will always be danger of the disease invading it (tuberculous osteoarthritis).

The pus is thin and contains detritus (bone sand). It contains very few bacteria and only very few cellular elements. It spreads into the neighboring tissues when the exudative pressure increases and follows the line of least resistance (gravitation abscess).

The **symptoms** of tuberculosis of the bones are most insidious. It frequently begins without any pain (spina ventosa), and only when the joint or the movable parts in and around the joint are attacked will pain arise. Tuberculous abscesses grow slowly, without much fever and with few local or general disturbances.

The **diagnosis** of tuberculosis of the bones is easy *per se,* but the diversity of the picture in the different bones may make it difficult. The swelling of the small tubular bones has been known for a long time as "*spina ventosa,*" and the process appears similar in the cuboid bones of the carpus and tarsus in which the inside of the bone is destroyed, though without much periosteal thickening (see Spondylitis). On the flat bones we observe multiple eroded foci which are surrounded by a low bony wall (Plate 11).

When abscesses form they grow slowly without any symptoms of reaction; the sites of perforation form ulcers with gray flaccid borders; the poorly nourished and disintegrating granulations, which represent the feeble and ineffective resistance of the body, protrude everywhere. The pus is usually sterile, but when we rub down the granulations or centrifuge the pus we will find the tubercle bacilli. Intraperitoneal injection of the masses in a guinea-pig proves the diagnosis through the death of the animal from tubercular peritonitis.

In the long bones we may have difficulty in differentiating the disease from osteomyelitis, especially when we meet one of those rare cases of either tuberculosis of the diaphysis or of epiphyseal osteomyelitis, and also when we have a case of the slow subacute type of osteomyelitis.

The radiogram may show the minimal reaction of the tissues and the lack of a periosteal wall in tuberculosis. The fever, course, and degree of pain may also be useful, but still there are some cases in which the diagnosis can only be made during or after operation (Lexer).

In smaller children we have an excellent means of proving the presence in the body of tubercle bacilli or their immune bodies in v. Pirquet's cutaneous reaction. If this should be positive, it will make a bone tuberculosis probable in small children. In older children, who usually have gone through some form of tuberculosis, only the negative result will be of any use. In very weak patients who are already succumbing to the general infection from miliary and meningeal tuberculosis, and in measles, etc., this test is inconclusive. But in these cases the general condition must be considered when making our diagnosis.

The *syphilitic affections* will not give any diagnostic difficulties when their gummatous character, their predilection for certain bones (diaphysis of the tibia), and the characteristic appearance of their products on close examination are considered. Finally, the result of antisyphilitic treatment, serodiagnosis, and the finding of spirochætæ will be decisive.

The general condition will be the principal factor in the diagnosis from rickets and from the rarer bone diseases (Paget's disease, etc.).

The **outcome** of the suppuration of the bone is generally favorable. If nothing should be done for it then the further course of the disease of the bone will depend entirely upon the general condition of the child.

Even very large foci will heal when the general health of the child improves. Should the body not be able to overcome the disease, then the foci in the bones and joints will multiply and the child will usually succumb to a general infection. Small encapsulated foci which persist in the scar tissue are by no means rare (Kaufmann).

Treatment of Tuberculosis of the Bones.—This has frequently advanced in the wrong direction. When we began to speak of surgical tuberculosis, we condemned these cases to the knife and often forgot to treat the general condition.

The following points should be borne in mind: Large foci and multiple affections of bones and joints heal spontaneously. An injury in a tubercular individual may be followed by a focus at the site of injury. As long as we guard against malpositions of the joints, nature will effect a spontaneous cure in the most satisfactory manner, which we cannot hope to imitate in an operation. As long as the body remains affected the healing of one focus will be followed by the formation of new foci and an operation is therefore useless.

From the above facts and also from the knowledge that tuberculosis of the bones is a secondary process and that even with the most radical cleaning out of this focus the primary seat of infection will still remain, we come to the conclusion that for the treatment of tuberculosis of the bones and joints in children only one method is permissible—*general systemic treatment aided by symptomatic local surgery*, which latter must be adapted to the nature of the trouble.

It therefore follows that the wide opening of tubercular foci and the customary curetting must surely be condemned, because we damage the surrounding tissues, open the road for new infection, and not only do we not remove the secondary focus but, on the contrary, we favor spreading the disease.

The injection of antiseptic drugs is not to be recommended, as they cannot be controlled on account of the deep seat of the disease. Strong drugs, such as formalin, crude carbolic acid, and camphor-naphthol, destroy the tissue. None of the newer remedies can surpass the iodoform treatment of Billroth.

The hyperradical treatment might sooner be advocated; this regards tubercular disease of the bones and joints as malignant growths which have to be removed within the healthy tissues (extra-articular resection of the elbow according to Bardenheuer, resection of the hip according to Lorenz)—resection of bones and amputations. But what of the primary focus, what of our much-vaunted conservative surgery when important parts of the body are sacrificed? A little thought will convince us that nature does this much more gently and with greater saving of life and function.

How many times have we not observed a new process immediately after an ample resection, and how many times have we caused a general infection (miliary tuberculosis, meningitis) with these major operations, either by spreading the infectious material or by lowering the vitality!

These considerations have induced us to avoid in our hospital service all major or "radical" operations for tuberculosis in children, and we are glad to say that our results have wonderfully improved.

1. *Systemic Treatment.* — Improvement of the general health and medical treatment.

The treatment with tuberculin seems to promise success. We begin with one-tenth of one milligram of tuberculin (Koch), slowly increasing the doses so as to favor the formation of antibodies. In one case of caries of the sternum which had been refractory to surgical treatment for years, we succeeded with this treatment in healing the process in four weeks, without any other surgical measures except the application of cups to the ulcer. At present, however, this cannot be considered as conclusive.

2. *Local Treatment.*—The affected part should be filled with more blood. This is accomplished by the application of a constricting bandage for from fifteen minutes to one hour but not longer (Bier); under this treatment we may at times observe a more profuse discharge of pus from the fistulæ, but this more rapid elimination of dead matter is not regarded as unfavorable. Ulcers are treated with cups the same as tubercular glands (Klapp).

Tubercular abscesses are never opened, least of all gravitation abscesses which are far removed from the focus in the bone. The ascending ones may be opened at their upper pole with a small opening to avoid the formation of fistulæ, the pus is let out and this is repeated until the discharge becomes serous, then we instill a few drops of a 5 per cent. iodoform emulsion into the abscess cavity and apply a firm compress fixed on the skin to avoid the leaking of lymph into this empty space.

Only in those cases in which the radiograph clearly shows a sequestrum are we justified in removing it to shorten suppuration. All scraping must be avoided and the cavity is filled with 5 per cent. iodoform glycerine; the rest of the treatment is carried through by the conservative method.

Wide-open granulating wounds (fistulæ) are treated in the same manner. Balsam of Peru acts well in these cases, as it is cleansing and may be used in ointments.

In favorable cases we may try v. Mosetig-Moorhof's filling. For this purpose the site is made accessible by lifting up a skin-flap in such a manner that the incision in the skin is not near the focus in the bone. The diseased bone is removed, taking care to reach healthy tissue; the bone cavity is next smoothed, cleansed with carbolic acid, followed by alcohol, dried with either concentrated alcohol or hot air, then filled with the iodoform emulsion and finally the wound closed entirely. Thus we are frequently able to cure the process. New bone may form in place of the filling, which is slowly absorbed (Silbermark), but usually a fibrous callus remains (Fig. 119).

Absolute rest is of the greatest importance when the affection is near a joint. This will relieve the affected tissues. The joint should be fixed in such a position that it will be the most useful in case it should remain stiff.

If the focus should threaten to break through into the joint we should make an extracapsular opening.

III. TUBERCULOSIS OF JOINTS

Etiology and Pathology.—The joints may be infected either from the neighboring bone (osteoarthritis) or metastatically by the blood current. In both cases miliary tubercles will be formed on the inside of the synovia, which reacts by exudation into the joint cavity, and also by exuberant granulations, which become caseous and break down, forming purulent foci that gradually fill the joint and destroy it.

The cartilage is eroded and lifted off the bone, which in turn is affected and filled with pus. The ligaments are also destroyed by the suppuration. Finally the pus will break through the capsule, thickened

from the reactive processes, and will appear on the surface (suppurating form).

More rarely the process will remain at the primary exudative stage (hydrops tuberculosus); these are the cases of quickly disappearing swellings of the knee- and hip-joints and what the French call "rhumatisme tuberculeux" (Poncet).

In children we also rarely observe the dry form (caries sicca), which is rather frequent in old people and in which the joint is destroyed without the formation of pus (see shoulder-joint).

The most frequent form in children is that in which the joint is filled with slowly growing granulations either with or without a primary exudate. The joint is in its characteristic medium position, the capsule is dilated and covered by the tense and glistening skin (tumor albus).

The fungoid masses distend the joint like a sponge (pseudo-fluctuation). The process may either stop at this stage and heal with the formation of scars and fibroid thickening or it may break down and form a joint abscess.

The **prognosis** is more favorable in children than in adults, as only a small percentage succumb to general infection (meningitis, amyloid degeneration). The prognosis is worse as to the function of the joints; the dropsical form alone leaves the joint intact, in all other forms the joint is generally destroyed. Healing takes place with fibrous scars which also involve the capsule and the ligaments and which make the joint stiff even if the denuded ends of the bones have not grown together.

The **general treatment** is identical with that for tuberculosis of the bones.

The suppurating joint must be regarded as a cold abscess and be treated accordingly (iodoform emulsion, camphor naphthol, Wreden). Otherwise each individual joint and bone offers so many varieties for clinical observation and treatment that it will be necessary to speak of each separately.

The **diagnosis** of joint tuberculosis depends upon the symptoms peculiar to each joint, but otherwise, with only few variations, is identical with that of bone tuberculosis.

(a) *Tuberculosis of the Shoulder-joint*

Symptoms.—The shoulder-joint is relatively rarely affected in children. It usually assumes the type of *caries sicca*, though all other varieties may be observed. The capsule is distended by a primary exudate or by the growing masses of granulations. The deltoid muscle which runs over it appears swollen and increases the protrusion of the shoulder.

In cases in which the process heals by fibrous scars or in those of the dry type the picture is just the opposite. The muscle atrophies

from disuse and the shoulder becomes smaller. The head of the humerus is very sensitive to pressure. Function is interfered with, the joint is held in the position enforced by its weight, namely, adduction and slight rotation inwards; any change from this position produces pain. Apparent motion can be produced in this joint by moving the shoulder-blade on the thorax, with the shoulder-joint itself held stiff.

Suppuration, either from breaking down of granulations or from the perforation of bony foci into the joint, produces the picture of a joint abscess.

FIG. 120.

Stiff shoulder-joint after joint tuberculosis. Boy of twelve years. Operated on three years after the beginning of the disease with para-articular resection and permanent elevation. The triple picture shows the motility gained by transferring the motion to the scapulothoracic joint.

The head of the humerus is eroded by cuneiform bone foci, and the epiphyseal line, which is inside the joint cavity in the shoulder-joint, is destroyed; the pus perforates the capsule and either follows the biceps tendon into the upper arm or it appears in the axilla or posteriorly below the scapula. The axillary glands are always affected.

Prognosis is bad owing to the nearness of the lungs. Healing always leaves a loss of function of the joint, unless the effusion is promptly evacuated.

The destruction from suppuration and the consequent formation of scars leave not only a stiff joint but also a shortened limb owing to the destruction of the epiphyseal line.

Differential diagnosis is not difficult. A collection of fluid in the shoulder-joint in a child should always arouse our suspicion, because traumatic omarthritis in childhood is very rare. Pyæmic infection of the joint or the periarticular tissues is characterized by its rapid course. Syphilitic separation of the epiphysis in small children is shown by the negative Pirquet test, by serodiagnosis, and skiagraphy (see Hochsinger, Syphilis, bone diseases). Fractures near the joint in the humerus, clavicle, or acromion are detected by careful examination and with the aid of the X-ray.

In paralyses we have passive motility while rheumatic affections are generally multiple.

Treatment must be conservative in children. It consists in proper position, in passive congestion of the shoulder (Bier), and general systemic treatment. Abscesses must be punctured where the capsule protrudes the most and may be injected with a few c.c. of a 5 per cent. iodoform-glycerine emulsion.

Cleaning out the synovia (synovectomy) and resection of the joints, recommended by some surgeons, are not permissible in children. Extra-articular foci in the metaphysis may be opened to prevent their breaking through into the joint.

Resection may be considered only to correct malposition long after the process has healed, but even then it is

Fig. 121.

Tuberculosis of shoulder-joint. Boy of four years. Duration of disease, four months. The arm is permanently elevated with a dorsal plaster splint (extreme position in bandage). When the splint is removed the arm is fixed in this position in the joint, but it can make all the important motions joined thus to the scapula.

better to leave it alone, as the focus may be only encapsulated, and we can make use of the motility of other parts to make the arm more useful.

In the normal joint any elevation of the arm above 90° is not done with the shoulder-joint but with the whole shoulder-girdle, i.e., by rotation of the scapula around its sagittal axis. We must therefore bring the arm in that position to the shoulder-blade so that elevation may be accomplished by moving the scapula. The inward rotation of the arm must also be done away with, because this interferes with the motility of the elbow-joint.

From these observations we may also learn something of the position of the arm in those inflammatory processes in the shoulder in which we might have to expect a fixation. Instead of putting the arm in a

Velpeau or Dessault bandage in adduction, we attempt an elevated position by weight extension and thus fix it with plaster splints. When the affection in the joint is healed we will then have a useful arm even if the shoulder-joint should have been entirely destroyed (Fig. 121).

Mobilizing manipulations and brisement forcé in narcosis are dangerous procedures because they may reawaken the slumbering process.

Intra-articular subperiosteal resection of the shoulder-joint should never be considered in children.

(b) *Tuberculosis of the Elbow-joint*

This is much more frequent in children than that of the shoulder-joint and is usually osteal. The foci are found in the humerus, frequently in the olecranon, and very rarely only on the caput radii. In the humerus the external condyle is often affected, whence the disease breaks through to the outside without infecting the joint, or the granulating and suppurating type of tuberculosis of the elbow-joint may follow the disease in the bone (Fig. 122 and Fig. 118, Plate 11).

The **symptoms** consist in gradual swelling and filling up of the joint, with increasing fixation and tenderness. The joint loses its normal contour and becomes fusiform; the joint is fixed in slight flexion and pronation (biologic position). All motions from this position and pressure on the joint are painful.

The fistulæ usually break through near the joint at either side of the triceps tendon where the capsule is closest to the skin.

Caries of the elbow may heal spontaneously, but this will always leave the arm in a fixed position in which it is of little use, as the hand can reach neither head nor mouth.

In the **diagnosis** only a trauma may make some difficulty, especially a hæmatoma after an overlooked injury (see Tuberculosis of shoulder and fractures of the elbow).

Treatment has to be systemic and prophylactic in this affection especially. The frequent extra-articular origin of the process offers a chance in some cases, after studying the skiagram, of opening the bone abscess externally, and we can thus prevent rupture into the joint.

Fig. 122.

Tuberculosis of the elbow. Boy of six years. Duration of disease one year. Skiagram Fig. 118, Plate 11. Steady advance of the process in spite of conservative treatment; then subperiosteal resection (Bardenheuer) on account of the general condition. Fistulæ for six months; then healing with good function and 20° motility.

Once the joint becomes tuberculous we must fix the arm on a plaster splint in such an extreme position of flexion and supination that the palm of the hand can easily reach the mouth. Furthermore, we employ conservative treatment, constriction, and injections of iodoform.

Of the operative measures, the early extra-articular resection of Bardenheuer is the one to be recommended. In this operation the joint is resected subperiosteally and removed as far as the healthy tissues without its being opened and with the avoidance of any injury of the muscles, blood-vessels, and nerves. The results are splendid as to motility, nor is the interference with growth as considerable as it is in the shoulder-joint.

This method is especially adapted to mobilize stiff elbows after the caries has healed for some time (interposition of muscles and fat).

The other operations, arthrectomies and resections (Langenbeck, Hüter, König, Kocher), can be considered in children only in extreme conditions when a life is at stake.

(c) *Tuberculosis of the Wrist and Finger-joints*

Tuberculosis of the carpus is rarely an isolated condition in children and is mostly seen in extensive tuberculosis of the bones. On account of their close intercommunication, the disease crawls from one joint and from one bone to another.

The hand is slightly flexed, the wrist is swollen, and the fold between the hand and forearm is filled out (frog-hand). Pains and disturbances of motion appear later, when the process has attacked the tendon-sheaths and the synovial sacs. Soon abscesses and fistulæ leading down to the foci in the bones will show on the surface.

The **prognosis** is unfavorable as far as the function of the hand is concerned, and the anatomic conditions favor a spreading of the process. Healing is accompanied by loss of function.

The **diagnosis** must exclude other kinds of chronic arthritic affections. In this we are aided by the course, the multiple involvement in arthritis and by the lack of bone foci in the skiagram.

Treatment must consist of careful position and rest of the wrist, constriction or suction, and other conservative measures. Hardly anybody would nowadays clean out the carpal sac in a child through the incision of Langenbeck and Kocher, since this would mean working inside the diseased area and it would be impossible to reach every synovial pocket.

Tuberculosis of the metacarpus and phalanges is identical with spina ventosa (Fig. 117). This type of tuberculosis of the bones is extremely frequent in childhood. It affects the short tubular bones of the hand and foot and leads, as described above, to the swelling of one

or more bones, which become fusiform and are painful to pressure. The skin over them remains normal for a long time, then it becomes slightly livid, and the abscess soon breaks through to the outside. Should it rupture into a joint, this will usually be destroyed and the tendon will be fixed when the tendon-sheaths are attacked. The skiagram shows slight distention of the bone, rarefaction, and a new periosteal shadow, also frequently a cavity inside the bone and at times a sequestrum.

This form is relatively benign, and after the general condition is improved, the swellings gradually disappear as the child grows, and the fistulae close after the small sequestra have been dissolved and eliminated. These facts should guide us in the treatment of this affection, which is usually multiple.

We should avoid any considerable interference, which would not only be superfluous anyhow, since all we are allowed to do is to aspirate the pus and to remove the sequestra, but, moreover, it might give us the unpleasant surprise of seeing the fingers that healed spontaneously show less loss in growth and function than those of the hand on which we have operated. We should place the fingers in the most favorable position, apply passive congestion, cup the fistulae, and make only punctate incisions with the careful injection of 5 per cent. iodoform emulsion.

In cases in which one of the short tubular bones has been entirely destroyed we may remove this as far as the healthy tissues, and when the wound has healed we may try the free transplantation of bone (Müller, Schmieden, Streissler). A splinter of bone with its periosteum attached is removed from the tibia, placed between the freshened ends of the epiphyses and allowed to heal in.

We amputate a finger only when it is entirely destroyed or is secondarily infected.

(d) *Tuberculosis of the Hip-joint (Coxitis tuberculosa)*

Pathology.—This is the most frequent tuberculous joint disease in children and usually attacks those under ten years of age (rarely infants); according to Dollinger the majority of those attacked are between four and six years old.

The disease may start from the synovia through hæmatogenous infection or from the bone itself and from thence spread to the joint. The primary synovial form is rarer in children and is found in 20 to 30 per cent. of all cases. The course of the synovial type is the same as in other joints: formation of tubercles and granulations, caseation, destruction of the bone.

In the osteal type the diseased focus is found in the bony structure of the head of the femur, the trochanter, or the acetabulum (König),

whence the infection advances to the joint, where it destroys the liga-
ments and bony parts.

When the head of the femur and the acetabulum are both being
destroyed, the latter will resist longer, owing to its firmer structure.
The whole head and neck may be involved, and when any weight is put
on the friable bone this will sometimes break at the neck and the head
will be found loose in the acetabulum like a sequestrum (see hip luxa-
tion, Fig. 50, Plate 8).

When the acetabulum is destroyed, any weight will cause the head
to move upward, thus extending the soft acetabulum upward (wander-
ing acetabulum).

In advanced cases we may find a position of complete luxation,
though the loosening of the caput mentioned above may simulate this.

The abscesses perforate the capsule and appear under the fascia lata,
either near the trochanter or at the lower border of the gluteal muscles,
in rare cases on the inside of the thigh.

Repair may set in at any stage of the disease, but only in the serous
and light fungous type do we observe total restitution of function; in all
other cases there will remain more or less stiffness of the joint in the
position it occupied during the disease. This is caused either by scars
or by osseous or fibrous ankylosis of the eroded joint.

The interference with the nutrition of the bones surrounding the
joint is quite apparent; the femur itself is much thinner and more deli-
cate in structure than that of the healthy side; this atrophy is caused
by diminished growth at the epiphyses, but still more by the inactivity
of the affected limb (see Paralyses) (Fig. 125c).

Symptomatology and Course.—A child otherwise healthy begins
to limp more and more (voluntary limp). The mother notices that the
child favors one leg, "it always stands on the sound leg." The gait
changes, since it leaves its weight for a shorter time on the diseased leg.

To minimize the pain when putting the weight upon this side, the
leg is held in abduction so as to get it as much as possible out of the axis
of gravity. This "position from pain," which can also be observed in
other painful affections of the leg, is the cause for the position in abduc-
tion which is apparent in the beginning of this disease (Fig. 123).

This side position of the leg will naturally increase the limp and the
uneven gait will make it appear somewhat like a jump. Fixation in
the abducted position makes the diseased leg appear longer. This is
most pronounced when the patient is lying flat on his back and the
sound leg is placed alongside of the diseased one (Fig. 125a).

Slight pains are usually referred to the knee by the little patient.
After a few days of rest all these symptoms may disappear entirely
(hydrops), though in some cases they will return more intensely. Should

a considerable exudate set in suddenly, then these initial symptoms will be more pronounced (pain on walking and fever).

Even in this early stage swelling and pain in the joint are present. If we feel for the place where the pulsating femoral artery appears under Poupart's ligament, we will find the hip-joint directly under the examining finger. On pressing deeper we will feel the increased boggy resistance, and this will cause pain (Calot).

These symptoms increase, the limp becomes more pronounced and the pain more intense. In the daytime the muscles are able to provide sufficient fixation, but when the children are asleep involuntary movements in their dreams will cause them to cry out with pain

Fig. 123.

Fig. 124.
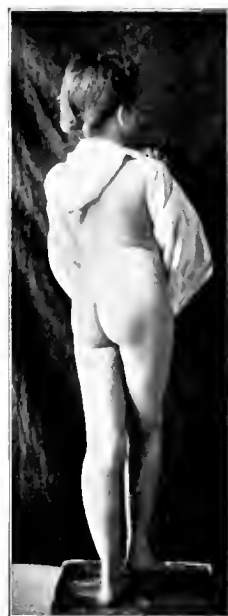
Fig. 123 – Incipient coxitis of right side. Boy of five years. Gait in abducted position. Duration of disease, two months. The boy is walking around and the abducted position of the leg makes it appear longer. In walking it is always placed sideways, to ease it as much as possible. The diseased side of the pelvis is lowered. Treatment: plaster cast without stirrup for one year, after which it was entirely ankylosed in good position.

Fig. 124 —Coxitis of right side (healed). Girl of nine years. Stands with strong adduction and flexion. Duration of disease, four years. During the acute stage the child was much in bed (fever). The right leg is now held considerably adducted and flexed and there ore appears shorter; to make it parallel with the sound leg the diseased side of the pelvis is elevated and turned. In spite of this attempt at compensation the toes reach the floor only when the knee is flexed Treatment:: subtrochanteric para-articular osteotomy, after which the limb was held in an over-correcting abduction in a plaster cast for eight weeks.

(night-cries). The patient usually avoids walking and either remains sitting or stays in bed. The hip-joint returns to its embryonal medium position (slight flexion). It sinks down in comparison with the other leg, following gravity (adduction), and is frequently supported by the other leg or fixed during the necessary motions of the body. The strong adductor and flexor muscles keep the hip-joint fixed in this position (Fig. 124). When the patient attempts to stretch out the legs and place these parallel, the adducted diseased leg will appear shorter, because the

equalizing motion has not taken place in the diseased and fixed joint, but the sound leg has to be abducted to make it parallel to the other.

Thus the diseased side of the pelvis is elevated, and further, the pelvis is turned around on its frontal axis in order to equalize the flexion of the diseased leg.

When we make these patients stand up, the adducted and flexed leg will naturally seem much shorter than the sound one. Slight flexion may be corrected by twisting the pelvis, but if it should be increased the toes will reach the floor only when the knee is flexed.

At the same time the fever increases, especially at night: it is high when an abscess forms. Temperatures above 39° C. (102° F.) usually indicate considerable absorption of pus.

The thickened region around the joint bulges in one place and fluctuation is soon found and the pus breaks through. This is followed by a long-continued period of suppuration which may last for years. When the pus begins to discharge the temperature will fall, but will rise again with the formation of a new abscess. Even in this stage the disease may heal after the elimination of the diseased parts.

In about 10 per cent. of the cases a fatal outcome of the disease is caused either from general tuberculosis (meningitis, miliary tuberculosis) or from amyloidosis in long-continued suppurations.

It is very easy to recognize the late stages of a coxitis or its consequences, but the functional disturbances on which we must base our early diagnosis are very slight; still, only by early recognition and by instituting treatment quickly will we be able to shorten the duration of the disease and to improve our results.

Examination of an Incipient Case.—First we examine the gait of our patient, stripped to the skin, and note any tendency to ease one leg by shortening that step. Next we note the position of the leg (abduction), whether the gluteal fold and the anterior superior spine are lower on one side (Fig. 123).

At this time we may sometimes be able to determine the lessened motion in one hip. We ask the child to stand on one leg, which he will hardly be able to do on the diseased one, nor will he be able to hop on this leg.

Now we put the patient on a table (not upon a bed) and place the legs in a parallel position. When the leg is extended the loin will be bent forward in a lordosis on the diseased side on account of the equalizing rotation of the pelvis (Fig. 125a).

When we elevate this leg until the lordosis disappears we get the angle of flexion (Fig. 125b).

When the suspected leg seems longer, this will indicate a contracture in abduction (measurement) (Fig. 125a). In older patients we can

easily prove this by asking them to lengthen the healthy leg; this they cannot do, owing to painful contraction, because they would have to adduct the diseased joint.

Now follows the examination of the voluntary movements. The child is directed to move both legs at the knees and the ankles, as well as in the hip-joints. The examination of the knee-joint saves us from making a mistake (localization of pain).

Fig. 125a.

Fig. 125b.

Coxitis of left side, early stage. Boy of five years, who had had a tuberculosis in the foot of the same leg. The coxitis is just beginning; duration two months; the leg is held in abduction with apparent lengthening (Fig. 86a). The small of the back is more hollow than normal. Only after adduction and flexion (Fig. 125b) can we find the true position of the limb.

Inspection alone will reveal that in certain movements of the hip the suspected side of the pelvis is moved simultaneously, and that therefore the motion cannot take place in the hip-joint (see Tuberculosis of the shoulder-joint).

We now fix the healthy side of the pelvis and let the patient make motions (flexion, rotation, adduction, abduction). The motions on the affected side are limited and rotation and abduction are the first ones to fail. Any attempt to transgress these limits by passive motion will produce pain. Pressure upon the sole of the foot is equally painful

when the leg is extended, also pressure upon the trochanter; pressure upon the head underneath the artery is painful as well. In this stage we may observe a pronounced atrophy of the muscles. All these symptoms taken together tell us of a beginning coxitis.

The later symptoms are still more conspicuous. Just as easily as we can recognize the contracture in flexion when we place the patient in the right position, just so will it be important not to overlook the contracture in adduction. The seemingly considerable shortening of the leg when placed in parallel position will be proven to be mostly apparent when we measure from the anterior superior spine to the internal malleolus; and the elevation of the diseased side of the pelvis (spina) will explain this. The actual shortening is caused by the destruction of the joint, though this will always form only a part of the apparent shortening. (L'inversion du membre dans la coxalgie c'est la source de tous les maux.) (Kirmisson.) And truly these fixations interfere most with the functions and cause the disagreeable changes in shape.

When we have once learned to recognize the early stages of coxitis the later ones will give us no difficulty. The correlation of the pathologic changes, together with the anatomy of the normal movements in the hip region, helps us to understand and analyze these.

The *radiogram* is an excellent aid. In the beginning it shows us the swelling of the joint cavity, indistinct contours of the bones in comparison with the unaffected side, considerable atrophy of the femur, and in some cases a peculiar protrusion of the bottom of the acetabulum towards the abdomen. In the later stages we observe on the plate the faulty position, the abduction, the rotation of the pelvis from flexion, the destruction of the bones, and perhaps a change of relation of the head to the acetabulum as an explanation of the true shortening (Fig. 125c and Fig. 50, Plate 8).

In making a **differential diagnosis** we have to consider lesions near the joint and diseases of neighboring joints, though these latter will not interfere with the motions in the hip itself.

Diseases of the vertebræ (spondylitis) may simulate a contraction in flexion in the hip-joint through the gravitation abscesses which proceed along the psoas muscle and appear below Poupart's ligament (painful contraction of psoas). But this will permit all motions in the hip-joint except extension.

Diseases of the knee-joint are found on examination, and the flexions of the hip in these are proved to be caused only by the flexion contracture of the knee, and that all other motions are free.

Osteomyelitic and pyæmic affections of the hip run a much shorter course. Aspiration of a few drops of pus and their examination under the microscope will explain their pathogenesis.

Traumatic affections are cleared up through their history and their course.

Rheumatic affections are multiple and deforming processes are rare in children, as are also gonorrhœic ones.

Luxations of the hip-joint are shown by the absence of the head from the acetabulum and free motility. Pathologic hip luxations are shown by the skiagram (Fig. 50, Plate 8).

In paralyses of the hip muscles, we miss the fixation and spastic conditions are not confined to the hip-joint.

True hysterical coxalgiæ are made probable by the general condition; should the diagnosis be difficult then the skiagram or examination under narcosis will aid us.

FIG. 125c.

Skiagram to 125a. This shows the advanced atrophy of the bone, the lowering of the pelvis, and the pronounced position in abduction, the rotation of the pelvis and the spreading of the process to the acetabulum.

Prognosis.—We have stated above that coxitis usually gets well. A small percentage only succumb to general infection. (In our policlinical material 10.5 per cent. of the cases.)

The earlier the child is brought for examination the sooner we can recognize and arrest the disease at its initial stage by treatment, and the better will be the prognosis, not only as far as the general health is concerned but also as to the function of the joint. Hydrops and the dry granulating type are benign. Night-cries, abscesses or high fever indicate a progress of the affection.

The **duration** of the disease is hard to determine; rarely in less than two years, often only after from four to six years, may we regard the disease as cured when we no longer find pain on pressure nor difficulties

in bearing weight. Even after all other symptoms have disappeared, night crying and restless sleep in these children will indicate that the disease is still present (lack of muscular fixation during sleep).

Treatment.—First in importance comes systemic treatment of the tuberculosis, of which the hip disease is only one symptom. The splendid results of Calot and Bowlby are mostly due to the favorable social conditions. Bowlby has treated 900 cases without a single resection or other major operation, and with only 4 per cent. mortality. (Hospitals at the seashore.)

For the **local treatment** we must figure upon a long duration. The physician, the child, and, last but not least, his parents must be endowed with the necessary patience. Children of the less intelligent and lower social classes should either be placed in institutions or the treatment should be so arranged that their care is possible and within the means of poor people.

Here, as in all other treatments requiring a long time, the social factor is of the greatest importance, and the percentages of cures must be looked at from this standpoint. Liberally supported, well located hospitals at the seashore or in the mountains or woods will give better results than hospitals in large cities, where treatment has to be carried out in the policlinic, and where the children, as soon as they have their splints, are returned to the surroundings where they caught the disease in the first place.

When a child whose social conditions are favorable comes to us for treatment in the very first stages, then we agree with Calot, who advises a long continued rest cure without any fixation bandages. But this method is adapted only to the strata in society uppermost in means as well as in education. It requires the best of nursing, a rest cure in the open air, and considerable firmness and tact to keep a child for many months from walking and even from sitting. Slight anomalies of position are corrected by the application of extension bandages and weights and by counter traction.

In most cases, however, we will find ambulatory treatment preferable with fixation apparatus which at the same time takes off the weight. This treatment permits the children to walk around, makes their care much easier, and is more beneficial for their mental as well as their bodily health.

Nothing is equal to a well-fitting plaster cast.

Now how should this be applied and what shall we do for the malpositions which are present?

Notwithstanding the differences of opinion which crop out all the time, we think that we will find the right method when we consider the pathologic anatomy, the condition of the disease, and the social condi-

tions. We are not treating cases but patients and our object is to obtain the best possible joint. We must therefore make our treatment as short as possible, and in order to do this we must treat the disease and the malposition together.

With the first plaster cast we correct the malposition by very slight pressure either without or with narcosis, and then put in a well-fitting and carefully moulded plaster cast with the least possible padding. This is done if possible in abduction, because nature teaches us that in this position the leg has to bear the least possible weight.

The bandage reaches from the lower ribs to the ankles to prevent motion in the hip when moving the knee. [The late Abel M. Phelps taught that the cast should reach above to the axillæ, because any shorter one will permit motion in the hip-joint.—THE TRANSLATOR.]

In some cases with a very painful exudate it will be advisable to let the cast reach down even to the knee on the healthy side, to prevent any motion in the pelvis during the painful stage.

The patient has to remain in bed as long as there is much pain. When this ceases we fasten a walking stirrup to the cast (see Walking-splints in fractures of the femur); on this the patient walks around; it keeps the heel from the ground and the cast transfers the weight to the tuberosities of the ischium, to which the cast must be moulded especially carefully if we want it to fulfil its purpose. When the cast is entirely finished we inspect this part of it once more, and insert here pieces of felt to keep back the soft parts and to bring the tuber ischii in close contact with the pad. In this way we take off the weight entirely and avoid constant slipping inside the cast. We must further see that the cast is not narrowed in below the tuberosity of the tibia, because otherwise the knee would have to bear the weight and not the tuberosity of the ischium. We place an extra sole under the sound foot so as to make them of the same length (see Fractures of the femur).

When pain is no longer felt on walking, then the stirrup is no longer needed and the abduction (Fig. 125d) will suffice; we must not try to anticipate Nature, as keeping the weight off the limb altogether has its disadvantages in increased atrophy of the bone.

Thus, treatment should be instituted and continued according to the symptoms. After the patient has been walking with the stirrup for some months, we begin to leave this off; if we can do this then we can cut off the cast at the knee after a few more months. We renew the casts at intervals of a few months.

Among the wealthy the plaster cast may be supplanted, in the after-treatment, by a brace (Hessing, Lorenz, Hoffa, Dollinger). But we must not omit to mention that even the best of braces does not work as well as a carefully moulded plaster cast, not to mention the frequent defects

in the material and the repairs. The brace should take up the weight at the tuber ischii the same as a cast and transfer it to a solid sole through metal braces; this sole should be several centimetres from the heel. The leg hangs in the apparatus and is held by an extension sling. We may also add to the braces contrivances to correct the malposition by means of pressure from springs or elastic traction.

We, as well as other authors, give preference to the plaster cast, because it works better and we order braces only during the period of after-treatment

FIG. 125d.

Same case as Fig. 125a in plaster cast, which corrects flexion but retains abduction. Little padding, careful moulding to the crests of the ilium.

FIG. 126.
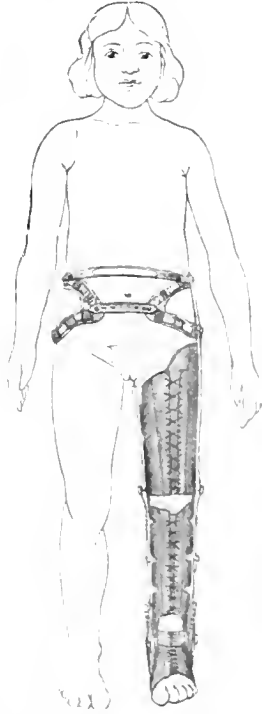
Brace according to Hessing. For the after-treatment of coxitis in the stage of healing. (From a drawing.)

Should we find severer anomalies of position, such as contractions in flexion or adduction, then these should be gradually corrected in the beginning of the treatment by extension; by slowly increasing the weights we can do this in a very few days, or we can do it in several stages.

Brisement forcé must be entirely condemned (Dollinger). Even in the apparently healed cases we can find infectious foci which can light up the process again. (Formation of an abscess!)

By increasing the extension with weights, dependent on the general health, and by changing over at times to casts, we will be able to overcome even the most rigid contractures of the soft parts.

In cases in which we have reason to suspect bony or fibrous union, we prefer the subtrochanteric para-articular osteotomy according to Gant or Volkmann to the conservative treatment (Fig. 121). This avoids disturbing the affected joint and may be done easily and without the least danger.

Should abscesses appear in the course of the disease, these should be punctured under aseptic precautions, emptied and injected with iodoform-glycerine (or camphor naphthol, according to Calot), but they should never, under any circumstances, be opened widely, because a secondary infection might easily set in during the long-continued treatment and this would give the disease a very serious aspect.

We may also aspirate the joint itself if we can prove that it contains pus (protrusion of the femoral artery, skiagram). This is best done, according to Calot, a little to the outside of the femoral artery at the typical point for the head. The canula when inserted at this place may easily be pushed down to the bone without any other injury; should it be closed by detritus it could be cleaned with a wire (Kirmisson) or by the injection of iodoform-glycerine.

Other surgical measures during the active stage would only be justified by a vital indication in progressive and profuse suppuration with high fever, but even then we should be satisfied with the most conservative surgery.

Of the resections we could consider in children only the total ones, the extra-articular elimination of the focus together with the joint (Lorenz, Reiner); but we would always hesitate before submitting a child to so serious an operation in the beginning, knowing as we do the splendid results of conservative treatment and being aware also of the fact that even thus we are not certain that we can remove the primary focus in its entirety.

When we can see on the skiagram that the head is loose and that it lies in the acetabulum like a sequestrum, then only may we remove it and thereby shorten the process materially (Fig. 50, Plate 8).

For opening the joint we make use of the bloody operations which we have described for congenital luxation, those devised by Lorenz and by Hoffa, and especially that of Kocher, which is best adapted to the anatomical conditions.

Curved incision from behind the trochanter major upwards to its apex and from there following the fibres of the glutæus muscle, curved

upwards and backwards. Then splitting the fascia, working down between the fibres of the glutæus maximus, then at the lower edge of the glutæus medius, between the glutæus minimus and the pyriformis down to the capsule. The insertions of the tendons of these muscles may be loosened subperiosteally and then the whole joint will be free before our eyes; we now remove only as much as we consider necessary to insure prompt healing. In progressive cases we cannot consider a radical cleaning out of the joint, because the resection of the head would have to be followed by a more or less extensive resection of the pelvis.

The mortality of resection is always large, perhaps because we use this only as the last resort in desperate cases.

(e) *Tuberculosis of the Sacro-iliac Synchondrosis (Sacro-iliac Disease, Sacrocoxitis)*

This is a seat of the infection which we have observed only rarely.

Pathology.—We find the same pictures of destruction and caseation; abscesses form as a rule and these frequently are the first indication of the disease.

After breaking through the capsule the pus appears at the surface through several openings in the region of the sacrum, or it collects at the anterior surface of the sacrum and follows the psoas muscle, filling the iliac fossa, to appear as a psoas abscess in the groin. In rarer cases it will follow the traction of the pelvio-trochanteric muscles, leave the pelvis through the foramen ischiadicum and appear near the trochanter major. Occasionally the pus will follow the sacrum and coccyx and appear as periproctitic abscess, bulging the rectum forwards.

Symptomatology.—Difficulty in walking and bearing the weight on the diseased side of the pelvis are the most prominent symptoms. On account of the undermining of the glutæus muscle and its insertion at the sacrum, we will frequently observe Trendelenburg's phenomenon, owing to painful insufficiency of this muscle (Spitzy). Pain can be elicited on deep transabdominal pressure against the synchondrosis, and still more pronounced on rectal palpation or when we examine bimanually from the rectum and the back.

Pain on pressing upon both iliac crests or in trying to move these against each other is pathognomonic; should we further be able to find abscesses, then the diagnosis will be sure, even without swelling on the back over the synchondrosis (Fig. 127).

The **differential diagnosis** from coxitis can only be difficult when an abscess traveling into the periarticular tissues makes motion in the hip-joint seem interfered with. (Careful analysis of motions and skia-

gram will clear the diagnosis.) When we find a psoas abscess we should always think of this affection, which also, without any doubt, causes many a periproctitic abscess.

Of the acute non-tuberculous infections of this joint we may mistake it for a perityphlitic abscess, and we should remember this when the other symptoms are not quite clear (author's observation of one case).

FIG. 127.

Sacrocoxitis sinistra. In the region of the left symphysis sacro-iliaca we found a pillow-like protuberance which gave deep fluctuation. Aspiration gave tuberculous pus. Operation showed disease in the sacrum and the adjoining parts of the os olei. Partial resection of these bones was done "within the healthy tissue"; this the child survived twenty-four hours only.

[Loosening or spreading of the sacro-iliac joint (Goldthwait) is more frequent in adults, but should be thought of; in this we will fail to find any signs of infection.—THE TRANSLATOR.]

The prognosis is worse than that of coxitis, which may be explained by the anatomical conditions. Years of abscesses and suppuration are liable to sap the child's vitality.

Treatment.—This must be restricted to removal of the pus, or in open fistulæ to the prevention of secondary infection.

In the non-tubercular types it is important to chisel the bone so as to give the pus the shorter route of exit through the back and thus to avoid further infection.

We were not able to note any good results in children from the major operations (partial resection of the pelvis according to Bardenheuer). These are too exhausting for the child's system and secondary infections set in too easily in this region. In children we prefer conservative measures: aspiration of the abscesses, injection, fixation of the pelvis and the leg of the diseased side, walking with crutches, the sole of the sound leg being elevated and that of the diseased side hanging free without bearing any weight.

(f) *Tuberculosis of the Knee-joint (Gonitis tuberculosa)*

This is, next to coxitis, the most frequent tubercular joint affection in children.

Pathologic Anatomy and Symptomatology.—We usually observe the granulating or suppurating type (fungus), the osteal, and the synovial forms.

In the osteal type the focus is usually located in the external condyle; skiagraphy is of great aid in determining the primary as well as the secondary foci (Ludloff) (Fig. 129, Plate 8).

In this affection as in coxitis, the disease frequently begins with an exudation (hydrops) which may disappear and reappear, or the characteristic doughy swelling will develop slowly; the knee-joint fills up with masses of granulations; all around the patella and on the sides at the ligamenta alaria the knee is puffed up, the skin covering it looks stretched and anæmic (Fig. 128) (tumor albus). The knee returns to its biologic position in moderate flexion.

The child steps on the toes, avoids putting its weight upon the limb, and carefully keeps its knee fixed. As the disease progresses, abscesses are formed which will break through and the child will have high fever (Fig. 131a).

Tuberculosis of the knee-joint shows no other differences either in its course or in its prognosis from the other tubercular diseases of joints.

Each type may heal at any stage, and the final outcome and the change in shape depend upon the amount of destruction. Hydrops may heal without affecting the function. The granulating and suppurating types leave the knee stiff from scars or rarely from bony ankylosis, and though small excursions are possible the leg can rarely be stretched out straight.

The position of abduction and outward rotation of the leg which we frequently observe is caused by the attempt to remove the leg from the line of gravitation and thus to bear less weight. The fixation in flexion increases from the contraction of the stronger flexors and thus only is the joint assured of a painless quiet position. Following the anatomical structure of the knee-joint, the articular surface of the tibia moves backwards around the rounded eminence of the condyles, the free cartilage is now eroded and destroyed by the tubercular process; and the leg can no longer slide back for extension. Should either an active or a passive extension be attempted after the acute symptoms have subsided, then the tibia cannot slide forward, and even when the leg is straightened the anterior inferior circumference of the condyles will remain exposed, the tibia being in permanent subluxation.

Diagnosis.—This is easy, only a traumatic exudate from one of the frequent unobserved falls of children may make some difficulty. In these latter cases, especially in small children, the negative result of von Pirquet's cutaneous reaction has been very helpful to the author. For the other diseases which set in similarly see Coxitis.

Treatment.—In gonitis in children, our treatment must be as conservative as possible. "The greater our patience, the better our results" (Schanz).

The superficial position of the joint makes removal of the diseased joint within the healthy tissues quite easy (see Elbow-joint). But later examination of these resected cases—this operation having been a

favorite one some years ago—shows that this joint, the solidity of which is continuously tested, is usually deformed after the wounds have healed, so that we were wont to speak of a deformity from resection (König, Kirmisson). This deformity is usually of the varus type; but we may observe all other forms of malposition, which is not in the least astonishing when we consider that atrophic bone has been united by the resec-

Fig. 128.

Tuberculosis of the left knee. Child of thirteen years. Duration of the disease, two years. The swelling is most prominent over the internal condyle and is doughy. Position in a flexion of 160°. Observe the abduction of the leg and its outward rotation, which is holden by the adduction of the foot. Aspiration gave sterile pus. Treatment: injection of iodoform-glycerine 5 per cent., congestion, extension with weights; discharged after four weeks with plaster cast. Healed after one year with stiff ankylosis.

tion, and especially when we remember that the growth in the epiphyses was disturbed.

In adults the results of these operations are much better, and in these the stiffened leg after a resection will be quite solid.

These are the reasons why, nowadays, surgeons generally prefer a conservative therapy in children.

Gradual straightening by extension with weights is desirable, in which special attention must be paid to the subluxation. We combine

PLATE 12.
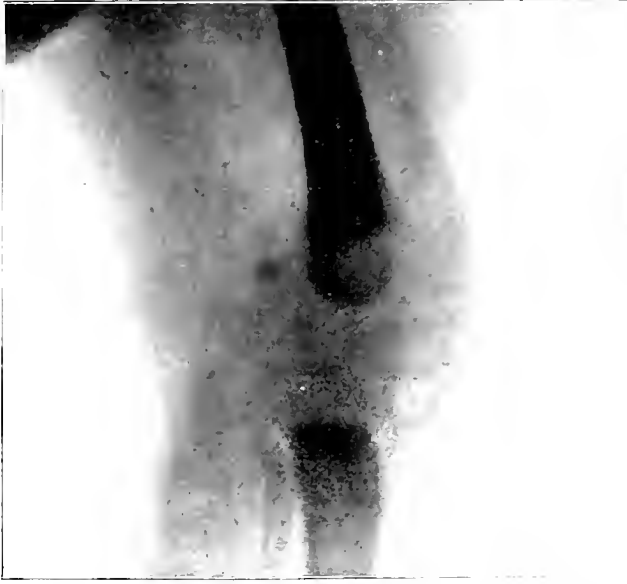
FIG. 129.—Tuberculosis of the right knee. Child of five years. The skiagram shows the spongy, unclear contour of the bones in the joint. The tibia is already slightly subluxated backwards; the capsule is dilated by the masses of granulations.

FIG. 132.—Spondylitis tuberculosa. Boy of twelve years. Figs. 138a and 138b). The bodies of the first and second vertebræ are attacked, especially their left side. About course of this case see Figs. 138a and 138b.

the extension in the long axis of the leg with a backward pressure upon the condyles and a forward leverage of the upper end of the tibia.

When the knee is nearly straight, then it is fixed in a snug plaster cast which must reach from the ankles to the tuber ischii; a stirrup is fastened in the lower end to bear the weight.

Fig. 130.

Tuberculosis of the left knee. Duration six months. Child of nine years. Plaster cast with redressing stirrup. The traction *a* presses the condyles backward; the traction *b* levers the upper end of the tibia forward; the legging *c* has at its lower end two guides *d*, which go through a slit in the sole and are fastened to the stirrup. These keep the leg, which is swinging in the brace, in extension.

This treatment of taking off the weight is persisted in as long as stepping upon the leg causes pain; then we leave off the stirrup.

By combining the plaster cast with elastic traction and steel rods we can get the extension while the patient is walking around in the cast, but this makes the casts heavier, less durable, and it takes a much longer time to make these, which latter fact is of great importance in policlinic work (Fig. 130). We prefer, therefore, preliminary extension with

weights, followed by simple solid plaster casts. Later on, towards the end of treatment, either a removable plaster cast or a celluloid or leather brace is given.

A fixation splint has to be worn for years to prevent the return of the contracture in flexion in cases of fibroid union.

For the wealthier classes of patients we have a choice among a number of braces, from the simple Thomas splint, which consists of a ring as a support for the tuberositas ischii and a long stirrup, to the

FIG. 131a. FIG. 131b.

FIG. 131a —Solid ankylosis in acute angle after tuberculosis of knee-joint. Child of twelve years, beginning four years before from traumatism. Then for years swelling and suppuration (scars from fistulæ). No suppuration the last eighteen months. No swelling in the joint, but no motility.
FIG. 131b.—Same case after cuneiform resection. (Circular incision according to Textor. Cuneiform resection within the healthy tissues.) Fixation was attained by sewing on the ligamentum patellæ. After the wound had healed a brace was worn for one year. Examination after three years shows slight varus position, but a solid leg.

exact but complicated braces of Hessing, the same as for coxitis except for the hip support (Fig. 126), in which by applying all the principles of technic we attempt to get fixation and at the same time prevention of deformity, in which we succeed if they are made carefully and applied patiently.

The treatment with apparatus should be combined with Bier's passive congestion. Should abscesses appear these have to be punctured (injection of iodoform-glycerine). Absolute cleanliness in treating the

fistulæ, protection from secondary infection by the application of tincture of iodine or balsam of Peru, avoiding all probing and scraping out, are especially recommended.

We are justified and forced to open and remove a focus in the bone, when we can thus prevent infection of the joint by making a para-articular opening.

Old and healed gonitic deformities, which do not yield to extension with weights, may be removed by wearing for some time a portable apparatus (Braatz, Hoffa, Hessing), but in all these procedures we must consider especially the subluxation.

Fibrous unions will yield to this. When the bones are ankylosed and the patella is in solid bony fixation we will not succeed without operative measures, but these should not be attempted until the disease is surely healed (not earlier than after four years), especially when we have to open the joint for a cuneiform osteotomy (circular resection according to Helferich) (Fig. 131b).

A subperiosteal resection without opening the joint means a capital operation which leaves considerable shortening (Flint, Wolkowitsch).

The para-articular supracondyloid osteotomy according to Ollier, which corrects the deformity outside the diseased joint by a counter deformity, seems better pathologically, and might also be done in the upper end of the tibia.

(g) *Tuberculosis of the Joints in the Foot*

Pathology and Symptomatology.—The joints of the foot are much oftener affected by tuberculosis in children than the joints in the hand. The disease is usually of osteal origin. The focus is in the caput tali, in the calcaneus or in tarsal or metatarsal bones, more rarely in the lower end of the tibia.

The **course** is similar to that in other joints, especially to that of the wrist; here also the communications between the joint-cavities and the tendon-sheaths favor a spreading of the process.

In the beginning we observe a swelling in the joint which is most pronounced at both sides of the tendo Achillis (upper astragalus joint). This increases, the gait becomes limping, and again we notice the easing position in abduction of the leg with outward rotation of the foot; rarely the opposite position, when a localization of the disease causes a varus position of the foot in fixation from pain (Hofmann). When the foot is not used we observe an equinus position.

There are fixation of the affected joints, loss of respective motions, formation of abscesses and fistulæ (see Gonitis, coxitis).

The **diagnosis** is made uncertain only by rheumatic and traumatic affections (history, skiagram, course, von Pirquet's test); a painful flat-

foot may at times make the diagnosis difficult, though painful flat-foot in children is rare and a one-sided one still rarer.

Tuberculosis of the different bones—calcaneus, talus, or the small bones and their joints—is recognized by the swelling over the respective site and tenderness on pressure on these bones, also especially by the skiagram (Fig. 119, Plate 11).

Treatment. — This in children is at first conservative. Rest is obtained by a plaster cast which must be well moulded to the tuberositas tibiæ below the knee and which, if motion should be painful, takes up the weight through a walking stirrup; we may also succeed with a brace similar to the one used in coxitis.

Should the foci be easily diagnosed and accessible in the tarsus, then these must be opened to avoid perforation into the joints. Especially in the calcaneus will we frequently find isolated foci which can easily be reached from without before they break through into the articulatio pedis (Fig. 119, Plate 11). Should the infection spread, then larger resections will be of little use, and we will try to succeed with the above-mentioned measures combined with congestion and injections of iodoform.

Total resection or amputation is only justified when life is in danger (Codivilla).

(h) *Tubercular Disease of the Bones and Joints of the Spinal Column* *(Spondylitis, Spondylarthritis tuberculosa)*

Pathology.—This form of tubercular infection is very frequent in childhood, especially in the first few years, and is most frequent in the second year of life (Wullstein). The weight then carried by the spine and intercurrent infectious diseases which weaken the system, as well as frequent injuries, are all of great importance in the etiology.

The vertebra most frequently affected depends upon the age of the child, as those vertebræ are the most frequently affected which are most used and injured at the respective age. Thus we will find in young children a preference for the lower dorsal spine, which appears to be most compressed and protruding in kyphosis from sitting. In adults the lumbar spine is more employed to carry the weight and is therefore the most frequently affected (Hoffa). The cervical spine is rarely affected, and the disease of the uppermost cervical vertebræ, which we know under the name of malum suboccipitale, is very rare in children.

The focus is as a rule found in the body of the vertebra, the loose network of the tissues of which offers less resistance to the entrance and the progress of the disease than the solid structure of the arches (skiagram, Fig. 132, Plate 12).

The synovial type plays a minor rôle compared with the osteal one and is only observed in the uppermost joints of the spine.

Lexer, through his studies of the normal blood-supply in the vertebræ of the young, has taught us the mode of the tubercular infection of the vertebræ. There are three principal distributions of the blood-vessels in the body of the vertebra. One pair enters the body from behind from the arteriæ spinales and forms many branches and anastomoses; two small arteries come from the periphery to the anterior surface of the body, and a third pair enters at the base of the transverse process.

The branches of the blood-vessels are especially numerous at the epiphyseal zone of the bodies of the vertebræ, and here we will most frequently observe the deposit of the tubercular embolus and the typical cuneiform focus.

The spread of the tuberculosis follows the typical course of the blood-vessels and offers nothing of special interest. It is usually the granulation type, either spreading from one centre all over the body of the vertebra or several foci in the epiphyses run together. Here also we find caseation, and occasionally suppuration. The process breaks through the intervertebral cartilages and attacks the next vertebræ, either through contiguity or through infection by means of the blood and lymph stream.

After one or more bodies of vertebræ have been destroyed, the weight of the body will bend the spine in such a manner that the healthy vertebræ come near together and the intact portion of the affected ones is pushed backwards. In this position fibrous or more rarely bony union may set in (formation of gibbus).

Naturally, in cavities in the bones, sequestra may develop and pus may be formed which will appear at some distance from its origin as a gravitation abscess. (See Abscesses.)

The most obvious change is the deformity of the spine. The granulating as well as the necrotic and the purulent type destroy the vertebræ, bend the spine, and force the spinous processes and the bodies of the diseased vertebræ backwards into the kyphotic protuberance. This is in the beginning button-shaped and pointed (angular type) (Fig. 133a). When the disease includes several vertebræ the protrusion will be more curved (arcuate type) (Fig. 133b). Thus we will see that the shape changes with the number of vertebræ affected. The arcuate type indicates a longer duration of the disease.

Should the disease be located more in the side of the body of the vertebra we will find the kyphosis combined with a corresponding scoliosis.

These primary deformities are followed by secondary compensatory ones, which will reverse the natural curve of the spine. A kyphosis in

the lumbar spine will be followed by a lordosis in the dorsal region; like-
wise a kyphosis of the cervical spine will make the natural kyphosis of
the dorsal spine disappear. Should, however, the kyphosis be located
in a part of the spine which is naturally kyphotic, then the physiological
curvature of the spine will be increased (dorsal spine) (Fig. 133b).

All the bony structures connected with the spine have to adapt
themselves to these deformities. In kyphosis of the dorsal spine the

Fig. 133a.

Spondylitis tuberculosa (angular kyphosis). Child of two and one-half years. Duration, ten months,
supposedly from fall on the back. Kyphosis at the eighth dorsal vertebra, not especially painful to pressure.
The spine is carefully held stiff. Walking impossible; standing only in position shown in the picture with the
arms supporting the body. Treatment: plaster bed.

thorax will be shortened and will appear telescoped from above down-
ward, but its depth is increased (pectus carinatum). The carriage of the
head is usually typical, and appears as if pushed forward and is sunk in
between the shoulders owing to the changed position of the cervical
vertebræ (Witzel).

All other organs must naturally follow the changes in shape of the
spine and the thorax (Wullstein).

As mentioned, tuberculous affection of the joints is of importance only when it affects the uppermost joint in the cervical spine, but this affection is much rarer in children than in adults. The synovial tubercles in this region will soon spread to the osseous part of the joint and will there run its typical course.

Nervous Symptoms.—When once the granulations have reached the cortex of the bone, they may protrude towards the inside of the spinal

Fig. 133b.

Spondylitis tuberculosa (arcuate kyphosis). Child of seven years. Duration, four years. Gradual beginning. No pain in kyphosis. Pareses of the lower limbs; can neither walk nor stand. Treatment: plaster bed.

canal, and thus cause a pachymeningitis externa; the dura is not yet changed, but soon it will become œdematous, thickened, and attacked by the disease.

These changes in the membranes will naturally affect the organ they cover. Its room in the spinal canal is narrowed, the circulation in its blood- and lymph-vessels is interfered with, until finally the cord itself suffers from the increasing pressure and is disturbed in its functions. The œdema alone may seriously affect the cord, according to Schmaus, and cause paralyses; though this will be still more pronounced when the

granulations break through and produce tuberculous changes in the meninges (Fig. 134).

Alteration in the position of the vertebræ as regards each other may bend the cord upon itself, or protruding sequestra or spurs at the site of the deformity may injure the cord.

Formation of Abscesses. — Abscesses which protrude or break through may act in a similar manner. But usually the abscess will follow gravity downward along the large vessels, then along the psoas muscle, filling the fossa iliaca and appearing below Poupart's ligament (Witzel).

As we have mentioned before, the pus may also ascend in the loose tissues and appear in the neck near the cervical blood-vessels. In spondylarthritis and suboccipitalis the pus usually breaks through backward under the skin, or it may sink downward and forward, thus forming the retropharyngeal abscess already described, and which may also be caused through ascent by tuberculosis of the upper and middle cervical vertebræ.

The pus from the lower cervical vertebræ follows the blood-vessels and may appear at the ribs along the intercostal vessels, but it usually sinks downward and then will take the ordinary route to Poupart's ligament.

Abscesses from the lower vertebræ follow the same course. Much more rarely the pus breaks through the back or follows other structures it meets (sciatic nerve, periproctitic abscesses).

Symptoms.—These are caused by the interference with the function of the spine by the disease.

Very early symptoms are segmentary pains which the children always speak of as a stomach ache (Judson). These are caused by the compression of the diseased vertebræ (Wullstein) (pressure upon the nerve-roots), and they are similar to other neuralgias.

FIG. 134.

Spinal cord from a case of spondylitis tuberculosa with total paralysis of the lower limbs, the bladder, and rectum. At the site of the kyphosis a firm mass of granulations is apposed to the cord, which completely surrounded the cord and strangled it.

The children will soon learn to eliminate the pains which arise whenever the spine is moved, by carefully fixing it by means of the muscles. Their carriage is tense, scared, as if they were listening (Fig. 133a). This is still more pronounced in their cautious gait.

When they are sitting, they brace themselves with the arms; in walking they clutch the nearest object for support or hold on to their own thighs to relieve the weight upon the spine (Figs. 133a, 133b).

When the spondylitis is high up, they support the head upon the arms, bracing the elbows, in order to lighten the spine.

When we ask these patients to pick something up from the floor, they bend only the hip and knee-joints and climb up on their legs with their hands, carefully holding the spine stiff (Fig. 135). When we ask

Fig. 135.

Tuberculosis of the spine, early stage. Child of eight years. Only very slight protrusion of the tenth dorsal vertebra to be felt. Considerable rigidity of the trunk; fixation of the spine from pain. Bending is done only in the hips and knees.

them to turn or bend the body sideways, we observe that this is never done in the spinal joints, but in the hips.

In advanced cases the children cry when placed in an upright position and are afraid to be touched by other people; in short, they avoid everything which might cause a painful motion in the spinal joints.

Nerve disturbances may appear very early, even before the deformity.

Beside the affections of the roots spastic disturbances of motion will be observed as the result of compression of the cord by the disease (œdema). Increase of the patellar reflexes, appearance of ankle-clonus, and rigidity of the muscles are the first symptoms.

The motor nerves are younger, biologically, and are therefore first affected, long before the sensory nerves and the vegetative ones show

an affection of any account, because these are much older and better established.

Spastic affections in the motor sphere appear first, and long afterward the first indications of sensory disturbances, such as formication and lancinating pains in the limbs. Motor paresis and paralysis always antedate the disappearance of the sensibility, only a long time after this comes the total interruption of the tracts for the bladder and rectum.

The deformity of the spine begins soon after the initial symptoms. First one vertebra protrudes like a button and increases very gradually. In some cases of a sudden breaking down of the destroyed vertebra this will appear rather quickly. As the protrusion increases, the above described compensatory curvatures follow. When the focus is located laterally in the body of the vertebra, a scoliosis develops which is fixed just as carefully as the kyphosis.

Course and Prognosis. —The whole disease takes a very chronic course. The beginning is hardly noticeable and therefore often overlooked. It runs its course for a number of years. Wullstein gives the mortality as 27 per cent. Death usually ensues as the result of systemic infection or from secondary affections (suppurations, paralyses).

The **prognosis** is absolutely unfavorable as to the retention of the shape of the body. A kyphosis almost always develops, and it fails to appear only in the rare cases of epiphyseal tuberculosis of the body of the vertebra or of tuberculosis of the arch. The more vertebræ affected the more pronounced will be the kyphosis (arcuate type).

Even this tubercular disease may heal at any stage. Fibrous or even osseous union of the remains of the bones, inspissation and calcification of the cheesy and purulent masses, retrogression of the œdema and granulations, as well as of the paralyses caused by these, may make a return to health possible.

Of the paralyses, those in the more resistant vegetative tracts will disappear first (bladder, rectum), then the sensory and last the motor functions.

Diagnosis.—This is especially important in the earliest stages because by promptly recognizing the deformity we may prevent much damage and we may be able to prevent the extreme deformities as well as a fatal outcome by our treatment.

Once the kyphosis has formed and is painful to pressure, or when paralyses and gravitation abscesses appear, then the diagnosis is no longer difficult; but in cases of incipient spondylitis in small children in their second year, which is the favorite age for this affection, the recognition of the first stages may be extremely difficult, particularly before the kyphosis appears or in a child with a possible rachitic kyphosis.

The child is stripped and its attempts at walking are observed. Careful fixation of the trunk when walking should arouse our suspicion. This will be still more pronounced when picking things off the floor or when attempting to twist the body. An oblique carriage of the trunk must also be noted. Then we palpate the spinous processes, as the protrusion of a single vertebra is detected quicker by touch than by sight. We should bear in mind, however, that in children the spinous processes frequently do not form a straight line.

The pain on pressure which is mentioned in the text-books is by no means reliable and cannot always be used for differential diagnosis, especially in young children. The examination for a passive lordosis

FIG. 136.

a, spondylitic kyphosis. Child of two and one-half years. Careful supporting upon the arms. b, rachitic kyphosis. Child of fifteen months.

gives better results. The rachitic kyphosis is fixed only when it is of a very high degree, and even then the arch is always flat. When we place the child face downwards and elevate the legs, the rachitic kyphosis of mild degree will be changed into a lordosis. The spondylitic kyphosis will always persist and attempts at correction will cause pain. When once the spondylitic kyphosis has reached the same size as a fixed rachitic one, differential diagnosis will not offer any difficulties. The diagnosis will be aided materially by the examination for nervous symptoms, increase of reflexes, lowered tone of the muscles below the kyphosis (fist pressure), disturbances of sensibility and motility, pains on motion, crying at night from involuntary motions (see Coxitis) and the appearance of abscesses.

A sarcoma may simulate tuberculosis of the spine. Carcinoma need hardly be considered in children (von Pirquet's cutaneous reaction,

proof of tuberculosis, absence of abscesses). The same may be said of the rare gummatous affections which can be diagnosed from the systemic disease (Wassermann's test).

Infections of the vertebræ other than tuberculous ones run a rapid course with high fever, while the tuberculous disease is without fever at first, or with only slight elevations of temperature (up to 37.5° or 38° C.) (99° to 101° F.).

Lateral deviations (scolioses) are shown to be tubercular by the painful fixation.

In cases of malum suboccipitale we frequently observe in addition to the fixation with the head bent forward a sideward twisting of the head and neck, especially when the next vertebræ are affected as well, thus imitating a torticollis position. If we look for the total painful fixation we will rarely make a mistake in these cases, and if we further remember that in torticollis only the counter motion is interfered with, and in spondylitis every motion.

Kirmisson calls attention to the fact that we may observe, by no means rarely, acute processes in the uppermost joints that are accompanied by swelling and fever (after angina, periostitis in that region). These begin like an acute "mal de Pott sousoccipital," but are easily distinguished from this through their benignity.

The **treatment** must keep in view many different points. Social conditions are here, as in coxitis, of the greatest importance.

The nature of the disease and the tendency of spondylitis in children to heal spontaneously will lead us to adopt conservative methods. We imitate nature in fixing the diseased spine. The weight is kept off as much as possible and the child brought under the most favorable external circumstances. The treatment is liable to extend over several years.

Hoffa, in his optimism, gave six months as the shortest time, while the author has never seen a case cured, *i.e.*, all symptoms disappear, in less than two years. In policlinic practice, however, the prognosis is considerably worse, because here not only the poor financial circumstances but also the low mentality, *i.e.*, lack of education of the parents, will militate against a sufficiently long-continued treatment. As long as we cannot place these children in proper institutions, open-air sanitaria or floating hospitals, just so long will our true final results in the treatment of spondylitis be far from satisfactory as far as the preservation of life and the avoidance of deformity are concerned.

Absolute fixation is the first desideratum which we can almost read in the anxious expression of the child's face. This is done in the best, the safest, and at the same time the cheapest way with a plaster bed, which forces the child to assume the dorsal position in which all weight is kept off the spine, and in which the internal organs do not suffer dur-

ing the long-continued treatment. This dorsal decubitus must be kept up for a very long time, as it is the only way in which we can keep off the weight entirely and thus reduce the deformity to a minimum (Lorenz).

The child is placed face downwards in a lordotic position on a table in one of the many kinds of frames. The author prefers the ventral position advised by Fink, in which the head is supported upon the elbows, because we then do not frighten the little ones. We prepare, according to Klapp's advice, at another table a plaster mould about six or eight layers in thickness, according to the measurements of the patient, which we apply and press onto the child while it is in the proper position and the mould still soft, and mould it to the body and head. We can thus prepare in a few minutes a useful plaster bed without being much disturbed by the struggles of the child. This method is better than that advised by Lorenz, who applies the bed direct to the body with bandages.

Fig. 137.

Spondylitis tuberculosa. Child of two years. Position in plaster bed. Observe the extreme lordosis; location of the disease in the eighth to eleventh dorsal spine.

This mould may either be padded and used as the bed, or it may serve as a negative from which to prepare a shell of celluloid or other material.

To these reclination beds (Lorenz) we can easily apply an extension apparatus for the head, if we should consider this necessary on account of the high location of the process or of the intensity of the pains (Sayre).

In children during their first few years and always during the florid stage we consider this method of treatment, which has been inaugurated by Lorenz and elaborated by Fink, the only sensible one and one which should be persisted in as long as feasible (Fig. 137).

Fink has shown that even a pronounced kyphosis may be redressed gradually and without causing any pains, through the weight of the child itself, by gluing tongues of felt to the skin around the kyphosis in the shape of a grating.

Only after all pain has disappeared do we permit the child to be placed in the upright position in the splint. Impatience on the part of

the parents or a yielding on the part of the physician will usually cause trouble. Even the best-fitting corset with the most ingenious jury mast will not entirely relieve the weight of the body nor prevent the formation of a gibbus, unless we apply strong plaster casts which include the head, such as Wullstein advises; but these require first-class technic and considerable orthopædic experience.

We keep our children lying down until they have absolutely no pain; then we give them a well moulded plaster corset (Sayre), which includes the head only when the disease is high up, or a well-fitting brace made of

Fig. 138a.   Fig. 138b.

Spondylitis tuberculosa in brace. Skiagram to this, Fig. 132, Plate 12. After keeping the patient lying in a plaster bed for six months, he was made to wear this brace for four years more. Healing with very small kyphosis (lumbar spine).

celluloid or leather. When the patient is accustomed to this, then we allow him out of bed, but we do not let him walk, but only creep at first, as this does not place any weight upon the spine and all side motion is prevented by the corset and still better by the patient's own muscles. This mode of locomotion is kept up for some months before the child is allowed to stand upon its legs.

For the after-treatment we recommend a steel brace similar to Dollinger's, constructed in two parts which are joined into one solid apparatus by four thumbscrews, thus making it impossible for the parents to loosen it and thereby to defeat its purpose by the loosening

of straps or laces etc. The anterior part leaves the chest and abdomen free and maintains the lordosis by bracing the upper part of the frame against the upper part of the sternum, which moves the least with the respirations, and by bracing the lower part against the hips where it fits snugly (Figs. 138a, 138b, 138c).

In policlinic practice we have found Taylor's back brace, an American apparatus, very serviceable for the after-treatment. It is easily made, gives sufficient fixation for this late stage, and its cheapness permits its free use in this class of cases (Bradford and Lovett) (Fig. 139).

In ancient times attempts were made to remove the kyphosis, and we read about this in the works of Hippocrates. Of late years Calot has brought once more the redressement forcé into short-lived revival. Only at the very first did he press "avec toute sa force" upon the kyphosis of the patient in narcosis while the spine was extended from both ends. But as soon as accidents and bad complications arose more and more he dared to press only "très doucement."

Wullstein has shown that the dangers and accidents in this procedure do not differ in the least from those of any other brisement forcé, and that it is vain to hope that the defects in the bones and the cavities which are caused by sudden tearing apart of the bodies of the vertebræ would be remedied; usually the opposite happens—that the process flares up anew. Steady

Fig. 138c.

Fixation brace. The back part is built like a Hessing brace upon two hip pieces, which must be well fitted to the crista ilei. The anterior frame follows in its lower part these hip pieces of the back part, to which it is fastened with two thumb screws. The upper part follows the contour of the thorax as shown in Fig. 138a.

pressure (Fink) by carefully graded bandages, which are applied in extension without narcosis, may be able to correct the deformity, according to the advice of Wullstein.

The dressings include the head and the extension apparatus described by Wullstein allows every necessary position, so that we can give exactly the reclination which we are able to maintain while applying the dressing. Later on the casts are exchanged for braces and corsets which retain the reclination and redressement, and which thus keep up our results.

In spite of the splendid results of Wullstein, we prefer Fink's treatment, because we consider that it is easier to carry out and better adapted to the nature of the affection and less torturing. It is best, however, to combine this method with occasional periods of extension bandages, and here as well as in other branches of our work we will succeed best if we individualize and show due regard for individual and social conditions.

The **operative treatment** does not offer any remarkable results. Abscesses are treated according to the above mentioned conservative

Fig. 139.

Spondylitis tuberculosa. Child of ten years in Taylor's back brace. (Instead of the single steel arch which goes around the buttocks in the original, we build these apparatuses also upon two hip pieces.) Two rods start from the hip pieces and run alongside the spine; these each hold a shoulder brace, which is to produce the lordosis, the anterior part is formed by an apron which holds the body against the back brace by means of the visible belts and straps.

rules, otherwise the only indication for operative interference is formed by persistent paralyses which do not yield to conservative treatment (laminectomy). These must be considered a vital indication, because they will surely lead to death from vesical paralysis if allowed to exist for any length of time. We first try rest and extension, to which paralysis from deviation will yield. These are most likely the cases in which

Calot's redressement has cured the paralysis. Wullstein recommends, therefore, the redressement brusque in these cases, but it is essential that we should first acquaint the parents or guardians of these patients of the possible dangers of such a procedure.

A Russian author (Wassiliew) has quite recently advised to approach the anterior surface of the bodies of the vertebræ by the retropleural route. Opening and drainage of congestion abscesses in that region through the back has in some cases cured paralysis. Laminectomy is the last resort, as is also chiseling open the vertebral arches. We remove the diseased tissues and the exuberant granulations and thus give the cord once more sufficient room (Bardenheuer). We cut down upon the spinous processes and the arches, resect them and remove as far as we can all diseased tissues, taking especial care not to touch the cord which is lying free in the dural sack (avoiding injuring the same through splinters of bone, also bleeding) (Trendelenburg, Bastianelli).

Massage and electricity are of use only in retarding the total atrophy which otherwise accompanies the interruption of the nerve current.

INFECTIONS OF THE LARGE CAVITIES OF THE BODY

I. THE INFECTION OF THE PLEURA (PLEURISY)

(Surgical operations on the thorax)

The pleura responds to infections of its cavity with pneumococci and other pus bacteria as well as with tubercle bacilli, usually with exudation which may assume a purulent character (empyema).

The percentage of cases of purulent pleurisy is greater in children than in adults.

For the symptomatology of the disease see Feer, vol. iii.

The **treatment** of empyema can only be surgical. Spontaneous recovery may happen in one of two ways, either by perforation of pus to the outside, when the soft parts covering the abscess are slowly lifted up and thinned until it finally breaks through the same as any other abscess (*empyema necessitatis*), or the abscess will empty into a bronchus after the lung tissue at its edge has been destroyed and the pus will be coughed up similar to that from a cavity.

We have, however, observed two cases in which we had been able to show pneumococci in the pus removed with a hypodermic syringe for examination, in which the parents refused all surgical intervention. These cases healed without perforation with formation of pleuritic thickening and a diminution of the horizontal axis of the affected side of the chest. After two years the function of the lung in its allotted space was good.

When we operate we must remember that we have to deal with an "abscess," though the conditions are complicated by the proximity of

the lung. Therefore the only thing to do is to let out the pus, especially in cases in which the symptoms of displacement and poisoning demand immediate relief.

The simplest and best method in older children is to open the chest with the *resection of a rib*.

General narcosis is superfluous as well as dangerous; chloroform because the heart is weakened by the suppuration, ether because it

Fig. 110.

Empyema necessitatis. Child of four years. Pneumococcus—pleurisy on right side, which has broken through the fifth intercostal space.

affects the respiratory organs which are already affected. Local anæsthesia with I per cent. novocain suffices for this operation, which should occupy but a few minutes.

According to Schede we select the lowest point. In total empyema and in the semilateral dorsal decubitus which these children generally occupy, this is found at the ninth or tenth rib between the posterior axillary line and the long dorsal muscles (an exploratory puncture should always precede the incision).

The incision should be as short as possible and goes at once through skin, soft parts, and periosteum, down to the rib. The periosteum is quickly separated from the rib, an elevator is pushed under this, thus

bringing it nearer to the surface, and it is at once removed with a bone forceps to the extent of 1 or 2 cm. We thus avoid injury of the intercostal artery. Should this, however, be severed, then we will rapidly finish our resection and tie the vessel later.

After removing the piece of rib we make a small puncture into the thickened pleura and widen this so far that we can just introduce our first finger through the opening. Now we let the pus out slowly, keeping close watch of the heart.

The introduced finger explores the position of the lung and removes clots of fibrin. Only when the general condition permits do we allow all the pus to escape. We consider the breaking up of adhesions and the washing out of the chest unnecessary, for the reason that this interferes with the processes of reparation.

A short drainage tube is then introduced which will not irritate the visceral pleura and secured with a safety pin pushed through it in its transverse axis and which is again fixed with a thread or a strip of adhesive plaster, so that the drain cannot be sucked into the pleural cavity with the respiratory motion.

The metal tubes of Lloyd built on the lines of a Murphy button are very handy, especially when we do not resect a rib but only do a thoracotomy, though we cannot recommend this latter operation on surgical grounds, because the narrowness of the intercostal space in a child makes it very difficult to keep the

Fig. 141.

Left-sided pleurisy. Boy of eleven years. Schematic illustration of linear puncture. The pus reached up to the fourth intercostal space (pneumococci, many of these intracellular, little fever). First puncture in fifth intercostal space; next day in same intercostal space only a little lower; then in intervals of one or two days going downward. Cure after eight punctures.

wound open and to introduce a drainage tube. Otherwise the wound is closed and a protective dressing applied, of which we only change the upper layers after three days on the advice of Hoffmann in order to give the lung a chance to become adherent to the chest wall and thus to avoid as much as possible the dangers of a pneumothorax.

The duration of the suppuration which follows varies considerably. In favorable cases it will cease in some weeks and leave almost normal conditions; in other cases again it may last for years. This depends almost entirely upon the stage in which we have operated; the earlier

this is done, the quicker will the lung re-expand and the suppuration be ended, while in an empyema of long standing the compressed lung will lose its power of expansion and will furthermore be fixed in the wrong place by rigid adhesions.

Thoracotomy should therefore always be done as early as possible and should be combined with the resection of a rib.

In children with a strong constitution and who have passed the second year of life all this is easy; younger children who have been weakened by the preceding pneumonia may be able to survive the operation, but they stand the long-continued suppuration and the consequent loss of liquid very badly. We have always had the impression that they wither like a fruit which has been cut (see Atrophy).

For these cases we have adopted another method which we would like to call *the linear puncture.*

We insert an exploratory needle about two fingers' width below the upper border of the pus and aspirate the pus which is above this with a syringe. The next day we aspirate in the same intercostal space. When we no longer find pus, we go down one intercostal space, and so on, until several punctures in the deepest intercostal spaces fail to bring pus. The number of punctures required varies between six and sixteen (in twelve cases treated by this method); in one case we had to resort to a resection of a rib after all, owing to continuous fever; this case ended fatally after long-continued suppuration (streptococci and diplococci).

Of our twelve cases, three with pneumococcus empyema on both sides made a full recovery, and this method has given us splendid results in desperate cases.

In a very poorly nourished child of four years with double empyema after pneumonia we succeeded in emptying the chest within one month, as we also did in the other two cases, and we succeeded with this method much oftener in young children than with the more radical operations.

This method is superior to Bülau's siphon drainage, Fig. 142 (see Feer, vol. iii), because by it we remove only a little pus at a time and allow the lung to follow gradually, while a total removal of the pus must be followed by so much more rapid an exudation with a continuous and tremendous loss of liquid into the vacuum if the lung should not be able to follow at once, the same as it does in early resection. We consider the avoidance of this loss of liquid and the creation of normal conditions of pressure as well as of osmosis one of the best recommendations in favor of our method.

In empyemas of long standing with suppuration of several years we must examine existing conditions with the aid of the skiagram.

In one case of a fistula which persisted for seven years after the resection, we were able to diagnose a costal sequestrum on the radiogram several centimetres in length, the removal of which finally ended the suppuration.

Schede's thoracoplasty, with the formation of a flap and the depression of the wall of the thorax, is an operation of such a magnitude as not to be applicable in children, nor is the peeling-out method of Delorme to be considered. The methods of Simon-Küster or Saubottin, who cut through several ribs to mobilize the rigid thoracic wall, are preferable. Bayer recommends the subperiosteal removal of several ribs in order to close the rigid pus cavity by the drawing in of the thoracic wall.

Considering all the different methods on the basis of more than one hundred cases of empyema in children, we would advise the following course of treatment:

In older and stronger children, early resection followed by conservative treatment, without washing out, at most application of the suction apparatus of Perthes to prevent the formation of a pneumothorax. (This apparatus consists of a suction bell which is fixed on the thorax by rubber valves; by pumping out the air from this we produce a slight negative pressure.) After the wound has closed we institute respiratory

Fig. 142.

Siphon-drainage in empyema according to Bulan.
(From Feer, vol. m.)

gymnastics with suppression of the respiration in the healthy side of the chest; we let the patient wear an elastic belt which brings the shoulder of the well side nearer to the pelvis of the same side, and we thus not only aid the respiratory expansion of the diseased side of the chest but we also prevent the development of a cicatricial scoliosis.

We advise the linear punctures in children under two years of age or in those who are much reduced, and also in double empyema we avoid all major operations on account of their large mortality.

The *examination of the pus* will aid us considerably. Should we find but few bacteria, most of which lie intracellularly, then the abscess is "getting cold," and we will succeed with the linear puncture even in older children in a short time; the fever will cease even with the first puncture, because it is caused principally by the reabsorption of the pus which is under high pressure. Should we find many bacteria, continuously high fever, the exudation reascending to its former height and the bacteria extracellular, then we will choose resection of a rib in stronger children. In smaller ones we might adopt Bülau's permanent drainage, though we cannot recommend this popular treatment from our own experiences.

The **after-treatment** must work towards the prevention of deformity from scars by means of respiratory gymnastics, antiscoliotic measures, one-sided crawling and portative apparatus which have the same effect in a recumbent position.

The walled-off empyema is treated according to the same principles and it is usually carried out easier; exploratory puncture, which has to precede any operation, will guard us against topographical mistakes.

Tubercular pleurisy (see Schlossmann, Tuberculosis, vol. ii) is rarer in children than in adults. The serous-exudative type will only be considered as a surgical disease when we let the aspiration follow the exploratory puncture.

The purulent-exudative type is treated according to the rules we have laid down above for purulent pleurisy; we must bear in mind the unfavorable prognosis and the poor general condition and refrain from major and weakening operations (linear puncture, Bülau, thoracotomy with Lloyd's drainage tube).

II. THE INFECTIONS OF THE PERITONEUM (PERITONITIS)
(Surgical operations in the abdomen)

For the symptomatology see Stooss, Diseases of the Peritoneum, vol. ii.

From the standpoint of surgical therapeutics the etiological differentiation of the different types of this disease are of the greatest importance. While those cases produced by the ordinary pus bacteria—diplococci, staphylococci, streptococci, pneumococci, and bacillus coli—differ only very little in their surgical treatment, the gonococcus-peritonitides from the adnexa and the tubercular affections occupy a separate position.

(a) *Diffuse Purulent Peritonitis*

This disease used to offer an exceedingly hopeless prognosis. When once the suppuration was somewhat general and advanced, and the peritonitis was recognized as a general diffuse purulent one, then this was

considered equivalent to a fatal result in a short time. The mortality was above 80 per cent. In children the prognosis was even worse, because the little patients were unable to survive major operations. The reasons for these deplorable conditions were to be found in the etiological and somatic conditions, and, last but not least, in the therapeutical procedures.

Pathogenesis.—We have divided the peritonitis according to its etiology into the rarer hæmatogenous and the more frequent one by contact. In this latter, infection arises either from the suppuration spreading from neighboring organs or from perforation of the intestinal tube through which the germs, which are always living in the intestine, are introduced in the abdominal cavity and infect it. The intensity of the infection varies considerably, and it depends partly upon the kind of germs which prevail and still more upon their virulence.

It is true that a streptococcus peritonitis usually is malignant (Franke), and that bacilli coli and diplococci as a rule give a more favorable prognosis, still we should not forget that under unfavorable circumstances a diplococcus peritonitis, and still more a coli peritonitis, may take a rapidly malignant course.

The *mode of infection* is also of the greatest importance. The peritoneal cavity may be flooded suddenly without any warning by considerable infectious material, as in traumatic perforations, or the infection creeps slowly in the peritoneum, thus giving the body time to call upon its protective apparatus and to repulse the infection. This is one of the reasons why infections which spread from the adnexa are more benign.

Appendicitis furnishes the major part of the peritonitides of childhood and all other etiological factors are of minor importance.

In appendicitis peritonitis not only the kind and virulence of the germ but the rapidity of the infection plays a large rôle as well. Acute attacks, which lead to perforation within a few hours, are known to give the worst prognosis in childhood.

The younger the child the less will be the chances of the walling off of the infectious focus, and the reason for this may be found in somatic conditions in the abdomen of the child; the relatively long length of the digestive tract, the smallness of the omentum and the less solid parietal fixation of the intestinal loops surely favor a more rapid spread of the germs.

We have observed many cases in which the intestine was in that stage of development in which the colon with the cæcum was still attached to a free mesentery. The appendix was lying free between the cæcal loops in the small pelvis. Recently more attention has been given to these anomalies (Wilms) and the more rapid spread of the infection has been blamed upon them.

Of the other types of peritonitis peculiar to childhood, we must mention first of all those caused by diplococci and pneumococci, most frequently observed in little girls, and the course of which is determined by the kind and virulence of the germs. The author, from his own observation of eight cases, must agree with Riedel, who is convinced that this infection spreads from the genital tract, and like the infection with gonococci it ascends from the genitals though the hymen be intact.

In one case we were able to prove this bacteriologically:

This was a case of an abscess on the right of the abdomen of a girl of four years. The appendix was close to the wall of the abscess and was thickened, but its mucous lining showed no signs of inflammatory changes. The ovary and tube were also close to the wall of the abscess. In the microscopic specimen of the pus we found grampositive diplococci which were identical with those found in the vaginal secretion before the operation.

This origin of the pus from the genital organs may also explain how the suppuration ascends along the peritoneal folds which lead from the ovaries and the bladder to the navel, and the predilection of this spot for the perforation of a diplococcus peritonitis.

The true gonococcus peritonitis (see Stooss, vol. iii) demands only rarely surgical intervention; conservative absorbent measures, rest, and application of heat will cause absorption of the exudates.

The **prognosis** of the cases of peritonitis after gross lesions of the intestine from injury, gangrene, or from occlusion of the intestine, invagination, or strangulation, is exceedingly bad. As early as twelve hours after the onset of the obstruction the intestinal wall will be pervious to its contents, though the protective powers of the peritoneum will still suffice against this infection, provided the amount of infectious material was not large. The child will be unable to cope with this infection if large amounts migrate through the intestinal wall or the peritoneal cavity is flooded with intestinal contents after gangrene of the intestine.

Another cause for the desperate prognosis in these cases in former times in the diffuse peritonitis of children was to be found in the prevailing treatment.

Treatment.—The fear of the knife as well as the excessive love for it were harmful. Here as in any other abscess it is urgent to empty the pus with which nature tries to get rid not only of the products of inflammation but also of its causes. The cure of abscesses of the abdominal wall, perforation into the rectum, vagina or bladder, prove to us this attempt on the part of nature; but they also show us the force with which the infection tries to spread.

All surgical interference was avoided during the first period. The next period every case of peritonitis was treated with wide opening of the

abdomen, flushing the intestine and washing out the abdominal cavity. The idea was to disinfect the pus cavity and to destroy the germs, but we forgot that it is much harder to injure the well-protected germs than the protective layer of the peritoneum, which is thus incapacitated from its normal function of utilizing the protective powers of the body (Witzel). This method of treatment was hard on the adult, but in children it was equivalent to a fatal ending, though they would have succumbed anyhow, as this was done only in advanced cases of peritonitis.

We therefore found it necessary to adopt even earlier for children the change in abdominal surgery which of late has been adopted for adults (Rehn, Murphy). It is now some years since we began to treat general peritonitis with conservative surgery.

We open the abscess in every case of diffuse or walled-in peritonitis which shows a tendency to spread. In order to avoid shock, we do not make large incisions. Even an otherwise healthy child (e.g., in an operation for a tumor) stands a large incision and eventration very badly; in the children who have been pulled down by the suppuration the shock will be directly fatal.

The line of incision is determined by the nature of the original disease (appendicitis, invagination).

We try to find the portal of infection as quickly as possible and close it (appendectomy, intestinal resection). The author does not rinse out the abdominal cavity, because he is afraid he might thus interfere with the natural protective action of the peritoneum.

The surgeons are still divided into two camps: those who wash out and those who do not wash out. Our own experience, which has been gained in children, militates against the washing out; we have never yet been able to observe any good from the washing out, but rather the opposite.

If any pus is accessible through the incision it is removed and the main collection is drained externally with drainage tubes made of glass or of rubber.

The teaching of Rehn, to close the abdominal cavity except for the drainage tubes, was a great advance in our treatment of peritonitis. The former open treatment and the packing with large amounts of gauze are now luckily things of the past. By placing the gauze-wicks against the loops of intestine and the mesentery, we frequently caused intestinal and fecal fistulæ, either through interference with the nutrition to the intestinal wall or through thrombosis or lesion of the mesenteric blood-vessels. Since we have given up this method fecal fistulæ have become rarer.

The closing of the abdominal cavity should be done as simply as possible and with the least practicable amount of suture material, to

avoid the expulsion of the sutures from the infected wound (whenever possible tobacco-sack suture of the peritoneum). We close the skin and fascia with figure-of-eight sutures which are tied on the skin.

The **after-treatment** has to avoid two dangers: ileus and weakness of the heart. The ileus is usually a dynamic one and is caused by the paralysis of the peristalsis from the suppuration and its toxins. By entirely closing the abdomen we place it again under its normal pressure and osmosis. The muscular contraction, together with the pressure from the diaphragm and the abdominal respiration, not only help in forcing the pus through drainage tubes, but they also place the peritoneum as much as possible under its normal conditions of function and blood-supply so that it can resume its fight.

Warm applications by means of thermophores or, because these cannot be borne on account of their weight, poultices or bags of chamomile, aid in re-establishing the function of the intestine. Rectal injections of glycerine and faradization of the abdominal wall are of service.

Of the greatest importance in these cases is the position of the patient in bed; to promote the discharge of pus the patient should be turned in the direction of the drainage tubes; Murphy advises a half-sitting posture whenever we have drained immediately above the symphysis or through the vagina. Smaller children are best placed in the right ventral position.

Should the paralysis be caused by agglutination of the loops of intestine, then the prognosis will be considerably worse; frequent washing with salt solution through the drainage tubes and oil infusions may give some relief, but they do not enter far enough; even counter-drainage on the opposite side of the abdomen has not given us any favorable results.

As a last resort we may do a colostomy and pull out the first distended loop of intestine which is met on reopening the wound, open this, let out its contents and then form an artificial anus. The author, however, has never been able to convince himself that this operation, which has been lauded by others as a life-saving one, does much good.

The condition of the cardiac function is of the very greatest importance. The inflammatory reaction in the abdominal cavity (considerable differences of temperature between the rectum and axilla) dilates the abdominal blood-vessels tremendously and the child bleeds to death, so to say, into its own abdominal blood-vessels. The exudation and the formation of pus demand further large amounts of liquid, and this causes a dangerous sinking of the blood-pressure and interference with cardiac action. Infusions of salines with adrenalin give temporary relief, but the amount of liquid in the blood diminishes more and more because the ingestion of liquid through the stomach and intestine is hindered.

Murphy has seen good results from the continuous rectal drop-irrigation of physiologic salt solution, but this is not feasible in children on account of their restlessness, and we therefore employ small hourly or half-hourly enemas of salt solution (microclysmata); they must be just small enough to be retained (about 100 to 200 cc.) and must be given as often as absorption in the rectum allows (half-hourly). As soon as vomiting ceases, the liquid should naturally be ingested by mouth. With this treatment we have succeeded in the last few years in saving 80 per cent. of our cases of general peritonitis.

Though we may claim some of the credit for this conservative mode of treatment, which is well adapted to the physiological conditions of the child, we will find that the principal reason without doubt in the early operating which is now finally and universally adopted is the strong and healthy heart of the child.

We must not wait in operating for peritonitis until all internal treatment has been proven in vain, until the heart has suffered from the intoxication and the sinking blood-pressure indicates imminent collapse, or until the diminishing leucocytosis (about method and value of blood-examination see Appendicitis) tells us that the body is succumbing: then the additional shock from the operation will only hasten the inevitable.

When we recognize every peritonitis, even the diffuse type, in its first stage and treat it at once according to the conservative principles we have just laid down, then we can give a good prognosis in children especially, though with the above mentioned limitations.

In some cases of peritonitis from perforation in appendicitis even the skin-incisions healed by primary intention though we were able to prove the germs from the intestine in the pus, and one case of coli peritonitis which had been general was able to leave the hospital cured on the tenth day. In two cases we lost the children between the ninth and eleventh day, after the nausea had ceased, the abdomen was painless, and normal stool had been passed, when fatal collapse set in; we were not able to show an embolism at post-mortem, but the sublethal symptoms indicated this accident; at that time we were still in the habit of draining the abdomen with large pieces of gauze (Mikuliez tampons). (Thrombosis in the mesenteric vessels.)

(b) *Tubercular Peritonitis*
(See Stooss, vol. ii.)

This affection was frequently mentioned in surgical literature a few years ago. Opening the abdomen and removal of the exudate was considered of great therapeutic value, though this could not be proven later on. The influence of light and air, the reaction of the tissues in healing, all these were given as causes for the disappearance of the

symptoms ot the disease. Lately this enthusiasm has rightly been stilled (Borchgrevink), because we can furnish most of these therapeutic factors cheaper and easier.

Tapping the liquid instead of its operative removal, Röntgen rays instead of letting in the light through a small incision, the suction-treatment with large bells, venous congestion upon the principle of Momburg's constriction, may easily do the same as an operation. We further found that the exudate, which is usually found to be sterile, contains large amounts of anti-bodies in solution, and that it is therefore a question if we aid nature by its removal.

In our own hospital service the operation has not altered the percentage of cures.

The following case may serve as an illustration:

In 1901 we operated on a girl eight years old for tubercular peritonitis by a median incision above the umbilicus. We found large quantities of liquid, the parietal peritoneum covered with nodules, the small intestines caked together into one lump, from behind which the exudate gushed out. Healing without reaction, child discharged.

Five years later the child returned complaining of pains in the abdomen and recently more frequent vomiting, though both these symptoms had been present to some extent all these years. Our diagnosis was influenced by the previous operation and we thought of an obstruction in the convolution of intestine, to separate which is very difficult even in the dissecting room. We operated on account of the increasing ileus and found strangulation of one loop of intestine around a ligamentous adhesion in the small pelvis. The child could not survive the resection of intestine, and died twenty-four hours after the operation.

On post-mortem we found that of all the considerable changes which had been caused by the tubercular peritonitis only one single caseous nodule, one mesenteric gland and the above mentioned adhesion which occluded the intestine had been left. Nature had so thoroughly loosened all adhesions and exudates. From this we learn that we should only consider those surgical measures in tubercular peritonitis which tend to lessen by the partial removal of the exudate the unnatural and painful distention.

The **differential diagnosis** will not be difficult when we consider the history of the case, the general condition of the patient, and make use of the diagnostic biologic expedients (Pirquet, skin test).

(e) Appendicitis (Peritonitis from Perforation)

Appendicitis is recognized as one of the most frequent causes of peritoneal infection. (Concerning its symptomatology see Selter, Diseases of the Appendix, vol. iii.)

THE SURGICAL TREATMENT OF APPENDICITIS

The mode of treatment of this disease seems to be definitely settled.

Indications for Operation.—Early operation offers the best chances, and even those physicians who were hesitating with the use of the knife and preferred expectant treatment—*i.e.*, internal therapy—as long as possible have now come to advise the early operation. The author has treated one hundred cases of appendicitis in children and based on these he is convinced that Riedel is right when he urges the necessity of an early operation.

[This and the following paragraphs will seem unnecessary and rather amusing to the American physician. While our German confrères were wrangling in their discussions about the right time for the operation and were wasting their time over this and losing their patients as well, we in the United States were firm believers in operating as soon as the diagnosis was made and had the best of results.—THE TRANSLATOR.]

The results of operations are just as good in children as in adults, as long as they are operated early enough.

Children, especially small ones, are very susceptible to infection from the appendix (Kirmisson, Neuberg). The threatening spectre of general peritonitis more frequently catches the child than the adult; true, the disease is rarer in infancy than later on (we have only observed one case in a child under two years of age).

If we should adhere to expectant treatment we take upon ourselves a heavy responsibility. The consensus of opinion is now, considering all the symptoms, that we cannot draw any conclusions as to the true state of the pathologic-anatomic conditions. We are taking greater chances by waiting than by operating, as long as we only proceed as conservatively as we are being taught to do by the most modern surgery. In the last two years we have not lost a single child which had been operated within twenty-four hours, and these included cases which showed decided cloudiness of the exudate and formation of pus around the perforated appendix which was not walled off and in the pus of which we were able to show streptococci.

The frequent question when to operate, should be changed into when can we afford to wait? Sonnenburg has taught us in his last publications a most admirable rule which we have employed for the last year with the best of results.

The treatment would be as follows: Every case of appendicitis should be sent to the surgical ward or a private room in a hospital as soon as the diagnosis is made. We can only adopt a conservatively expectant treatment without assuming grave responsibilities when we keep the knife near at hand. Only under these conditions can we afford

to wait in simple appendicitis, though the diagnosis of this is by no means easy and we may frequently make grave mistakes. The fever usually does not exceed 37.5° (99° F.), the pulse is not above 90 nor the leucocytosis above 15,000. In such a case we have to deal, according to Sonnenburg, with an exudation into the appendix, which could not be discharged owing to valvular closure, cicatricial contraction from an old and overlooked chronic process or through biologic involution. In these cases a light laxative, one or two tablespoonfuls of castor oil, may cause increased peristalsis and removal of the exudate.

Should this not have the desired effect, or the leucocyte count, pulse, and temperature rise (38° (101° F.) (100 : 20,000), and we find a large number of young leucocytes, then we were either mistaken in our diagnosis or the process is progressive and our only salvation lies in the knife; even if the process should regress we are by no means sure that we have not made a mistake in diagnosis.

A boy of eight years was sent to our ward with a diagnosis of appendicitis in the first stage. Owing to the symptoms we have just given we considered this to be a case of appendicitis simplex and treated the child with castor oil. The symptoms decreased and the child was dismissed at the end of a week. After six months he returned with a second attack and was operated on, and we found the site of an old perforation, a scar, which surely dated from the former sickness. From this we saw that at that time we had not to deal with a slight sickness and that we had then been misled by the symptoms.

Empyema of the Appendix (Plate 13).—When the pain at McBurney's point is considerable but still confined to this region, and the temperature and the leucocyte count rise, we have most probably to deal with a purulent process inside the appendix, an empyema, which will either end in perforation or has already perforated. Rectal examination, by which we can, even in a child of three years, palpate the abdominal cavity above the navel and can bimanually examine the whole cæcal region, will give us valuable information. This is also safer and less painful than deep palpation.

Deep palpation should be carried out in expiration. The examining hand glides deeper with every expiration and we will soon be able, even in refractory children, to reach the iliac fossa and the arteries. Palpation of the appendix is always somewhat problematical, as we may be deceived by loops of intestine in that region or by the psoas muscle (the latter we can recognize by motions in the hip-joint). Only when the appendix is very superficial and when it is distended by empyema can we feel it and make a diagnosis with any assurance.

If we operate in this stage, we may save the child from perforation and consequent abscess. We are able thus to remove appendices which

PLATE 13.
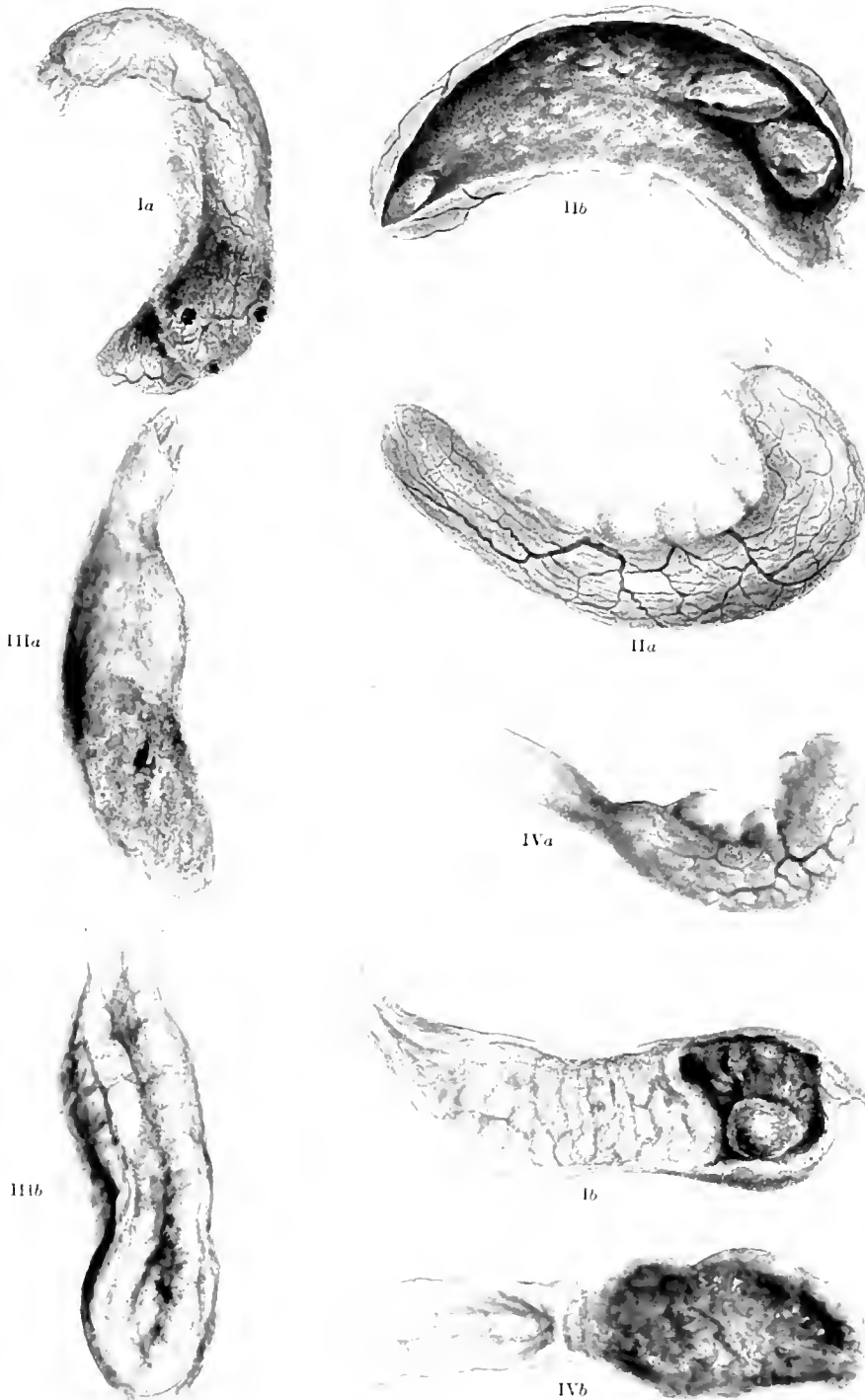
FIG. 143.—I. Empyema with gangrene and perforation. Three openings. Fecal concretions. Circular scar. Diffuse peritonitis. II. Empyema with gangrene. Fecal concretions. Total gangrene of mucosa. In the neighborhood cloudy serous exudate. III. Simple perforative type. Mucosa intact except for exceedingly small ulcerations. Fibrinopurulent exudate on the serosa. Abscess in Douglas's pouch containing much pus. IV. Fresh empyema of the appendix, with gangrene of the mucous membrane beyond an old stricturing scar. Beginning inflammation of the serous coat. Thrombosis of veins in the serosa. Slight injection of the neighboring intestinal loops. Surrounding tissues otherwise free.

Every appendix is represented first from the outside, then cut open from the inside. All belonged to children of from six to fifteen years of age. From Selter, Diseases of the Appendix, Vol. III.

are filled to the bursting point. The wound will heal in a few days and the child will thus be spared a long period of internal or surgical treatment which would be inevitable after abscesses have formed from perforation.

Peritonitis from Perforation. — Once we can clearly show the exudate, by the dulness and the resistance, per rectum as well as from outside, then we will have to deal with a walled-off purulent peritonitis, and expectant treatment is only permissible when we can prove satisfactorily that the symptoms of exudation and inflammation are retrogressive as well as the pain, and that fever, pulse and leucocyte count are going down together. We have known for a long time that even large purulent exudates may disappear either through the lymph-channels or by going back into the intestine, rarely by perforation into neighboring organs, and we may thereby justify our expectant attitude. But when no retrogression is perceptible, or the abscess remains tense and shows a tendency to burrow further, or the rectal temperature and the pulse remain high, then we must not wait any longer before we open the abscess.

The operation must be done most carefully; if we can reach the appendix easily we should remove it, but we must never be carried away by our desire to remove the offending organ and in doing this break through the protective wall, as we would then be doing our patient small service. If we cannot reach the appendix easily, then it will be better to wait with its removal until the painless interval, when the process has quieted down. In cases in which it maintains a continued suppuration it should be removed earlier. The abscess-cavity is emptied, drained and closed (Rehn, v. Brunn), and the patient placed in that position in bed in which the pus can run off easily. Our incision must naturally be determined by the location of the abscess. Should Douglas' pouch be filled with pus, then we may advantageously open it through the rectum, after first ascertaining that no intestinal loop is interposed (exploratory puncture with a fine needle (Battle)).

Generalized Peritonitic Suppuration.—We have described above the treatment of a diffuse peritonitis. Removal of the appendix is here also indicated to close the source of infection.

Chronic Forms.—After the first attack has passed without operation, leaving only chronic tenderness, frequent exacerbations of pain from distention with gas and from bodily exercise, and when the first attack has been followed by a second one, then it will be absolutely necessary to do an interval-operation "a froid." This is an entirely safe operation which will procure for the patient freedom from his intestinal disturbances.

The postoperative pains from adhesions which are frequently reported in adults have never yet been observed by us in children. The

lively peristalsis in children and their innate tendency to get well do not permit so easily pathologic processes which largely depend upon advancing age and occupational damages.

For *nonoperative treatment* there will therefore be left the following:

1. Those light cases of appendicitis simplex which are difficult to diagnose but which we may treat internally if we only keep the knife in readiness (Sonnenburg). We must, however, beware of mistakes.

2. Closed abscesses which show a distinct tendency to absorption.

3. Desperate cases with general peritonitis in which the crossed chart (high pulse, low leucocyte-count, low blood-pressure) indicates the losing fight of the body. The majority of these cases perish; a few only may be guided by internal treatment, stimulants and endermoclysis, around the dangerous rocks to where they may be saved by operation.

We must now add some cases which were operated on account of a continuous low fever accompanied by pains in the region of the appendix. In seven cases the appendix was normal and only showed slight reddening, but in its tip we found nests of oxyurides; in one case we found large numbers of ascarides, and we may therefore be permitted to speak of these cases, which are by no means rare, as *helminthic appendicitis*.

Operative Findings.—The conditions we find at operation confirm entirely what we considered of importance etiologically. Doubling up, twists, adhesions, strictures of inflammatory and biologic origin, together with irregularities of digestion, constipation, colitic swelling of the mucosa, all these cause the occlusion of the appendix, the formation of fecal concretions, disintegration of the exudate, and all their consequences (Fig. 143, Plate 13).

The operative prognosis is determined in the first place by the time at which we operate.

Interval operations are almost entirely free from danger, though we must always be prepared for surprises which are usually due to a complicated location of the organ (adhesions, scars).

Early operations are almost equally safe, when done within the first twenty-four hours. Technically they are easier, because adhesions have not yet made the finding of the appendix difficult. Only the most malignant types of streptococcus-infection detract from the marvelous result of early operation.

The intermediate operation, when abscesses have already formed, gives a bad prognosis only in those cases in which the discrepancy between the virulence and the power of resistance of the patient is too great, or when we are not sufficiently careful at the operation. Its prognosis can naturally not be quite as good as that of the early operation because it cannot be strictly separated from diffuse peritonitis, and because the multiplicity of the abscesses considerably influences the chances of recovery.

The technic of the operation changes according to the type we have to deal with. In early or interval operations, in which we do not expect to meet any difficulties, our special attention must be directed to preserve the muscular activity of the abdominal wall as much as possible, and the permuscular operation through the smallest possible incision is here surely the only method.

After the third day, if no reaction has set in, we may allow these children out of bed (Kümmel); on the seventh day we take out the sutures and dismiss the patients.

Should we find a purulent exudate around the appendix, then we wipe this off and drain externally with a glass tube or a piece of rubber-tissue (Lennander).

In cases in which we suspect an abscess, we use the para-rectal incision (Lennander, Kammerer), which allows a better view into the abdominal cavity and which guarantees a good muscular closure in case the suppuration does not last too long (provided we have avoided the nerves supplying the posterior fascia).

In other cases the incision must be made according to the location of the abscess, and we may choose among a large number (Sonnenburg, Riedel). We drain down to the deepest point we can reach (Murphy), and also arrange the patient's position in bed according to this. But we always close the abdominal wall entirely except for the drainage tubes, even in cases of walled-off peritonitis. To avoid fecal fistulæ, which formerly were a frequent and unfavorable complication of the healing of these abscesses, we have abandoned the gauze packings. Should we insert strips of gauze, then these should not come in contact with the sutures in the intestine, and rubber-tissue is better.

Jansen recommends to be careful in loosening adhesions in cases in which the cæcal wall is much infiltrated, and to leave out the toilet of the appendiceal stump, as the sutures would cut through easily and then a fistula would form. The stump is only clamped off and tied (perhaps also subserous peeling out (Thevenot)).

We, as well as others, now pull down the omentum in all suspicious looking cases and fix it broadly over the dangerous spot in the intestine.

Fecal fistulæ do, however, close up spontaneously after a long time, if no unfortunate accident, such as the formation of a spur, protrusion or prolapse of the mucous membrane, interferes with this. At first we must be patient; the more so the younger the child. We must always remember that an operative closure of a fistula may easily lead to a resection of intestine, an operation which small children rarely survive. In some rare cases we may be able to go in through an incision next to the fistula, loosen the fistulous gut from all sides subcutaneously (the same as we do in umbilical herniæ) with blunt instruments, tie it off,

invaginate it, and close fascia and skin over it. Should the fistula be
of some size, then the defect will usually include most of the circum-
ference of the intestine. It will usually be impossible to close the loop,
which is frequently adherent by a linear suture, so that only resection
will have the desired result.

We have given up rinsing out and injecting antiseptics in suppura-
tive appendicitis. The much lauded treatment with collargol, per
rectum as well as intraperitoneally, has never given us any beneficial
results, though we have used it often.

Distant abscesses, subphrenic or left-sided ones, must be opened
under the same precautions; and always remember that in the close
proximity of the abscesses to the blood-vessels the germs may quite
easily spread further (empyema, pneumonia).

(d) *Invagination and Intestinal Occlusion as a Cause of Peritonitis* *(Operations in Intestinal Occlusion)*

For the symptomatology of invagination see Fischl. Intussusception,
vol. iii.

Prognosis and treatment of invagination: Whenever a diagnosis of
intestinal occlusion has been made it can only be relieved by radical
measures. Not only in the congenital occlusions but also in the strangu-
lations and invaginations of older children the ileus and the pain in the
abdomen will induce the surgeon to operate. Only in that form of occlu-
sion which is most frequent in infancy, intussusception, do we still try
a reduction with internal measures or non-surgical applications. The
reason for this may be found in the good results reported by Hirsch-
sprung (60 per cent. of cures), which are quoted again and again, though
their correctness is doubted by many (Klemm, Braun). We can expect
a cure only when we are able to succeed in the reduction within the first
twelve hours. Those cases, in which a successful reduction through a
laparotomy is reported as late as after forty hours, were such in which
the mesenteric vessels were not entirely shut off, and such cases may at
times recover spontaneously and then persist through life (chronic
invagination).

A boy of six years was suffering from digestive disturbances for a
long time, complained of frequent stomach-ache, and was finally brought
to the hospital in an attack of appendicitis and was operated on account
of the symptoms. The appendix was found red and swollen; above its
base an old invagination was found, which was covered on all sides by
peritoneum and did not show any acute symptoms. (This boy had been
at the hospital when eight months old on account of an invagination,
which had, however, been "reduced" with clysmata.) After removal of
the appendix one was able to see the invaginated but pervious piece of ileum

in the cæcum (Fig. 145). On account of the weak condition of the patient no resection was performed, but an artificial anus was made instead at the insertion of the appendix, from which one was able to probe the invagination. The child recovered, the passage remained free without probing, the stools followed the natural channel, and the fecal fistula became smaller, but had to be closed later by an operation.

In this case the swelling accompanying the appendicitis caused an obstruction and occluded the lumen of the intestine, which was not overlarge.

FIG. 145.
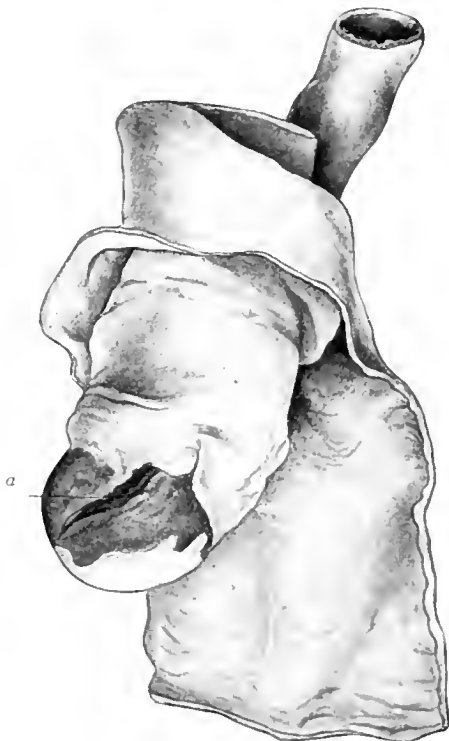
FIG. 144.

FIG. 144.—Invaginatio cæci. *a*, necrosis of the intussusceptum. From the collection of the German Pathologic Institute in Prague, Prof. Chiari. (From Fischl, Intussusception, vol. iii.)

FIG. 145.—Intussusceptio ileocæcalis incarcerata. Piece of intestine removed by operation, hardened. Longitudinal section.

Against such benign cases we must mention those in which the mesenteric vessels are tightly constricted within ten hours and the circulation entirely shut off. The gangrene in these cases prevents reduction (Fig. 144).

We see from this that we cannot draw definite conclusions from the symptoms as to the extent of the anatomical changes and that the

immediate operative exposure of the invaginated part is the only safe procedure. If a high irrigation does not loosen the loop at once, then it would be criminal to wait longer with the operation.

The best procedure would be as follows: Light narcosis, only enough to relax the abdominal wall, careful examination, deep palpation during expiration and bimanual examination from the rectum, high enema, at the same time preparation for an operation. Should the enema not succeed in reducing the invagination, which we can easily feel through the relaxed abdominal wall, then we proceed at once with opening the abdomen and bringing the tumor into view. Here again we must avoid all eventration, only the invaginated part is brought out of the abdomen, the other loops are returned at once. We now proceed with the manual loosening in such a manner that the tip of the invaginated part is slowly pushed back. All pulling on the invaginated intestine must be avoided on account of the danger of its tearing. If we are unable to loosen it, or should we observe gangrenous places, then we must decide to remove a piece of intestine, which, however, gives an unfavorable prognosis in children. Infants especially rarely survive this.

Manual reduction is therefore mostly to be desired, because it is easier to save a child when the serous coat has been torn and when we have to leave some suspicious spots, which we may carefully cover with omentum, than when we had to do a resection.

The technic of resection is determined by the location of the invagination (small intestine, caecum); as a rule we will succeed with the ordinary methods of abdominal surgery.

An exception is the resection according to Jesset-Barker, who tries to reach the intussusception through a longitudinal incision in the invaginating gut; he then applies a circular suture through this incision and extracts the invaginated part, thus imitating the occasional spontaneous cure, in which the intussusception becomes necrotic owing to the constriction of its mesenteric vessels and is passed out through the intestine, while the intestine heals at the line of demarcation without perforation into the abdominal cavity.

The chances of recovery from resection of the gut improve with every year of life. Thus we succeeded in a boy six years old, in whom the invagination was caused by a sarcoma at Bauhin's valve, in making an anastomosis after resecting the ascending colon and a piece of ileum, though the prognosis was quite unfavorable owing to the location of the resection (large intestine) (Fig. 192a, 192b, Plate 21).

The resections made necessary by *congenital occlusions and malformations* usually end fatally; still we must attempt to make a permanent cure by eliminating a piece of intestine or by anastomosis rather than give temporary relief only by making an artificial anus; because

this latter procedure only means putting off the inevitable, as we will hardly ever succeed in preserving life by this, but it may enable us to defer radical operation to a more favorable time.

Ileus from strangulation will also give a fair prognosis in children when it is relieved in time, before it has caused peritonitis or demands a large resection. We must always think of the possibility of an ileus from the strangulation of a Meckel's diverticulum, especially in cases

Fig. 146.

Megacolon congenitum. Child of five months.

which present other congenital malformations; also of strangulation from a healed tubercular or purulent peritonitis with adhesions (see tubercular peritonitis).

The *megacolon congenitum* (Hirschsprung), Fig. 146, would require the elimination of the whole of the colon, which operation has been tried repeatedly and was successful in one reported case. The anastomosis of the ileum with the rectum requires both considerable technical ability and a very resistant patient.

The **technic** of all these operations—artificial anus, intestinal resection and extensive plastic surgery of the intestine—is identical with that

in adults, but we must always remember that the long time consumed in the operation and the protracted narcosis may be fatal to the child. Our motto in all abdominal operations in children must therefore be to work as simply and quickly as possible. We must avoid all eventration and chilling of the intestine, because this will cause fatal shock in children. We must attempt to do all our manipulating extraperitoneally, so as to interfere as little as possible with the vitality of the peritoneum. Only under these conditions can we count upon good results in abdominal surgery in children.

Prolapse of the Intussusceptum.—In extreme cases the invagination may go on; the intussusceptum proceeds down the colon and rectum and may be felt in the latter like a portio uteri; finally it may even prolapse through the anus, and will then give a picture similar to a rectal prolapse, with this difference, however, that the mucous membrane of the prolapsed gut is not directly continuous with the mucous covering of the anus and that we are able to carry our finger around the prolapsed part within the rectum. The intussusceptum will naturally pull down more and more of the gut into the intussuscipiens, which will be most ominous in those cases in which the colon has a free mesentery. In these instances we cannot differentiate between invagination and prolapse, and the whole colon may come down as a prolapse at the apex of which we observe the invaginated ileocæcal valve.

Treatment in these cases of prolapsed invagination which we cannot replace is identical with that for gangrenous prolapse of the rectum.

(e) *Prolapse of the Anus et Rectum*

(See Fischl, Prolapse of the Rectum, vol. iii.)

Under the same conditions as invagination, we may observe in children the reduplication of the rectum into itself and the protrusion from the anus, the genesis of which is the same as that of invagination (prolapsus recti) (Fig. 117). When only the mucous lining of the anus protrudes, we speak of a prolapse of the anus (Fig. 118). Between this and the prolapse of the entire colon to the ileocæcal valve all stages are possible (see Invagination). In large prolapses the peritoneum is pulled down as well, and into these peritoneal pockets intestinal loops may enter (rectal hernia).

Etiology.—The mesentery of the colon and the sigmoid flexure being often freer and longer in children, will favor the formation of prolapse as it does that of invagination. Added to this, is a vertical position of the coccyx and also of the rectum (on account of the insufficient tilting of the pelvis in the beginning of the erect position), sometimes also a congenitally deep Douglas's pouch (Hoffmann), so that we may

regard the majority of cases of prolapse as the consequence of a congenital predisposition together with an insufficient adaptation to the erect carriage. Loosening of the pelvic floor through the loss of fat and lessening of the muscular tonus and increased intra-abdominal pressure are the most evident etiological as well as causative factors. Should polypi or hemorrhoids be present then these will also favor invagination, the same as do tumors of the intestinal mucosa higher up (see Sarcoma).

The most dangerous time for the formation of these prolapses is the beginning of the stage when the body is carried erect, *i.e.*, between the first and third year of life. The rectum, which is still adapted to the horizontal position, is now placed vertically, and increased demands are

FIG. 147.

Prolapse of the rectum and anus (of one day's duration). Child of five and one-half months. Sudden appearance of very large prolapse, more than 15 cm. in length, including besides the rectum the sigmoid flexure and colon descendens (free mesentery). We were able to bring it back and to keep it back permanently with adhesive plaster dressings.

made upon its ligaments and the pelvic floor. This will be lessened again when the pelvis is tilted (lumbar lordosis) after the spine has found its final equilibrium for the erect carriage. The highest degrees are represented by those intermediate stages between intussusception and prolapse, in which the whole colon comes down owing to its free mesentery, and in which Bauhin's valve appears at the apex of the prolapse, and through which the small intestine may also prolapse. We have seen such a case in a child of one month, which was later found to be a cretin and showed other defects of development (permanent cure by two paraffin bars).

The first conditions (weakening of the pelvic floor) are found in atrophic infants suffering from gastro-intestinal disturbances. Frequent stools, tenesmus, rapid loss of fat, and wasting are directly responsible

for this process. In older children, of from two to four years, digestive disturbances or straining on the chamber are to be blamed. Later on when the pelvis is tilted (physiologic lumbar lordosis) and when the rectum moves further backwards in the erect posture, as corresponds to our origin from the quadruped mammalia, then the prolapse in children will either have disappeared or will only be very rarely found.

Prognosis.—From this we might assume a very favorable prognosis. If we can keep these children alive until after the fifth year of life, then the prolapse will usually heal spontaneously, if this is not prevented by congenital conditions or tumors.

Fig. 148.

Prolapse of the anus. Child of five years. Duration three years. Permanently cured by two injections of paraffin, forming bars.

The symptoms from the exposure of the rectal mucosa and from secondary changes (hemorrhoidal tumors) are such that their frequent recurrence or when we are unable to keep the prolapse back will endanger the child's life. The sphincter ani and the muscular pelvic floor may be so weakened and distended that they are no longer able to retain the replaced prolapse. We have also observed four cases in which a long persistence of the prolapse led to occlusion of the bowel and to necrosis which was similar to that observed in invagination.

Treatment.—It is therefore necessary to remove this condition as soon as possible. In accordance with the tendency of this affection to heal spontaneously, we may succeed in a large number of cases by removing the etiological factors. The digestive disturbances should be over-

come. The child should be properly cared for and brought into clean and hygienic surroundings. The forcible straining at stool must be avoided and the children should not let their legs hang free. The tendency to prolapse will disappear if the above precautions are taken. Should the anal opening be relaxed, then we will usually succeed with simple strapping with adhesive plaster.

Although this is simple, it will be better to describe minutely how it is done. We place the child on its abdomen and lift it up by the legs. Traction of the mesentery will tend to pull the prolapse back and it will then be easier to replace it. Then the buttocks are pressed together to invaginate the anus to some extent. This position is retained by applying overlapping strips of adhesive plaster transversely, below and in front we leave a small opening for the defecation (Basewi, Fischl).

Though a large number of these cases can be cured by this strapping if long continued, there will still be left a considerable number in which we will have to operate.

The most frequently employed methods of operative treatment consist mainly in the narrowing of the anal opening, in diminishing the mucous surface and in removing the prolapse.

According to Thiersch, we replace the prolapse and then carry a silver wire subcutaneously around the anus, and then twist the two ends together until the anal opening is of normal size. The wire remains, as a rule, without causing any reaction and is removed after one year. Rotter reports twenty-seven cures in thirty-one cases.

Hoffmann's method is also to be recommended. He makes a crescent-shaped incision in the posterior raphe around the anus and tightens the sphincter and the pelvic floor with transverse sutures and closes the skin over these.

Rehn removes a circular cuff of mucous membrane from the prolapse and gathers up the muscular coat by longitudinal sutures, thus forming a muscular ring over which the mucosa is again united.

These operations give good results in adults and would also be applicable in children if we did not usually have to deal with badly nourished children whose weakened bodies cannot stand these severe measures.

We have therefore adopted a simpler method, namely, the longitudinal *stiffening of the rectum with bars of paraffin*.

This method is easily carried out and under the proper precautions it is without any danger and may easily be endured even by the weakest child. At our hospital we proceed as follows:

We first try the internal and bloodless measures; when we find that we cannot keep back the prolapse and that external circumstances do not permit a long-continued treatment, we admit the child into the hospital. Here we replace the prolapse, wash out the rectum and treat the

child with retentive dressings until the mucous membrane shows no more excoriations and is entirely normal. We now wash out carefully and then proceed in light narcosis, after carefully disinfecting the anal region, to inject the paraffin. We take hard paraffin of a melting point of 50° C., place it in a water-bath, and prepare a 5 c.c. hypodermic with a canula of 8 to 10 cm. in length. We fill this syringe with the paraffin, insert it 1 cm. from the anal opening posteriorly and externally and push it in for about 6 or 8 cm., to the pararectal tissues, under control of the finger in the rectum and taking good care that we do not get too near the mucous membrane. We now begin to inject, withdrawing the needle at the same time, and we stop injecting about 1 cm. from the skin and quickly withdraw the needle entirely. We thus form a continuous, more or less bar-shaped longitudinal stiffening which hardens rapidly; the same is repeated on the other side. After the injection, we apply the overlapping adhesive plaster straps for two days. After the first normal stool, the child goes home.

In 1906 we made an inquiry among our patients and found only one relapse in thirty-two cases (in this particular case only one bar was formed). Even the above-described tremendous prolapse caused by a free mesentery was permanently cured by the formation of two paraffin-bars.

Owing to its great merits, we now use this method exclusively in our hospital service.

Accidents may happen when the surface is ulcerated, but in these cases all other methods will be subject to the same difficulties. We can never find out how deep these ulcerations really are, and the suppuration may therefore reach the bars and cause infection. This happened in one case in which we were obliged to remove the paraffin.

Although we have not observed a single case of embolism or conditions which might indicate this in ninety-two cases thus treated up to 1910, yet we have lately so modified this method that we no longer form bars by injection, but we now prepare sterile rods of hard paraffin, 8 mm. in diameter and from 6 to 8 cm. long, which we place pararectally under the skin. For this we introduce a sufficiently large trocar near the anal opening similar to the needle; after we have pierced the skin we withdraw the stylet and push the blunt canula forward into the pararectal tissues to the hilt, thus avoiding all bleeding. We then introduce the prepared paraffin rod through the canula and push it up as high as possible with a probe, and now remove the canula over the rod and the probe, and lastly we remove the probe. The small opening in the skin closes at once or may be closed with a clamp. After-treatment and results are the same as in injecting the bars.

Instillation is only a more precise way; the rod has a measured size and position, while the bar has an irregular shape and position and is

therefore not as easily removed in cases of infection as the smooth straight rod; the technic is also easier because the molten paraffin hardens very quickly and we had therefore to work very rapidly.

When we have diagnosed a gangrenous prolapse we must avoid all operative measures until the mucous membrane is healed. Once the gangrene has progressed so far that we can no longer loosen the loops of intestine, then we will have to consider a resection of the prolapse, because an attempt at a forcible redressement might lead to a peritonitis from perforation of the gangrenous part. Lenard proposes that we should make a fecal fistula at the sigmoid flexure and remove the prolapse gradually with intestinal clamps, as had been advised before by Weinlechner in such cases though less radically. A hard rubber tube is introduced into the lumen of the prolapse until it reaches above the anus; after replacing a possible hernia we ligate the prolapse just outside the anus with a piece of rubber tubing, and in from eight to ten days it will come off. This last method has the disadvantage that we cause intestinal loops or peritoneal folds to become gangrenous, still in very weak patients who could not stand an operation we may have to choose it as our last resort; elevating the pelvis, most careful examination, and, if necessary, replacing the contents of peritoneal pockets may aid us in avoiding danger.

FISSURE OF THE ANUS
(Symptomatology, see Fischl, vol. iii.)

This consists of a loss of substance of the mucous membrane at the border line of the anus, usually posteriorly. The constant play of the sphincter and its continuous forcible contraction interfere with the formation of epithelium over the ulcer.

In those cases in which internal treatment fails (diet, local application of anæsthetizing suppositories, cauterization with silver nitrate 5 to 10 per cent., tincture of ratany, cupri sulphas, potass. permanganate) we will only succeed in getting a final cure by excluding temporarily the action of the sphincter muscle. The sovereign remedy is the bloodless dilatation in very light ether narcosis. The operator introduces both thumbs or first fingers and dilates the anus so far that the sphincter tears, and during the consequent paresis of this muscle the ulcer heals. After the procedure we apply hot fomentations, keep the patient in bed for two or three days, and procure soft stools by the proper diet.

The bloody operation consists in incising the fissure, but this is hardly ever done in children.

Periproctitic Abscesses.—These may easily form in the loose perirectal tissues through infection from the intestine (foreign bodies, splinters of bone) or from long persisting deep fissures.

The anatomical conditions of the pelvic floor, its successive closures by the sphincter externus, the sphincter internus, and the levator ani muscles, and the interposed fasciæ may give very varying symptoms of suppuration in this region, from the slight diffuse perianal swelling and infiltration which protrudes into the rectum and will soon lead to a fistula, to the grave ascending gas-forming infections, caused by the bacterium coli mixed with other malignant germs, which may end fatally by reaching the peritoneum. They can undermine the tense tissues closing the floor of the pelvis.

In all cases the **treatment** can only be operative and must take place at once to prevent spreading. The superficial abscesses are opened radially, best right into the anal opening, analogous to the operations for fistulæ, because we can thus best exterminate the abscess cavity. We also try to reach the deeper abscesses through the skin, as opening these through the rectum is rarely sufficient. The line of incision varies with the location of the infiltration. Should the suppuration go over the middle line, we will best make it accessible by a transverse incision parallel to the sphincter and between the anus and coccyx; then we dissect upwards until the pus cavities drain to the outside.

The **after-treatment** should see to the drainage and a posture which will assure an easy flow of pus, keeping in mind the possibility of interference with urination, because this may be affected either mechanically (compression by the abscess), or through infection (propagation to the muscular coat of the bladder), or through nervous reflex influence.

FISTULA OF THE ANUS

The anal and rectal fistulæ usually arise from the above described infections; they have, therefore, as a rule an internal communication with the rectum as well as outer opening, because the infection comes from the rectum, though we are not always able to find this opening (complete and incomplete fistulæ).

One exception is found in the tubercular fistulæ, which, however, are rare in children; in these we must always think of the possibility of a gravitation abscess which has taken this road in the loose tissues, the origin of which may be high up on the pelvis or on the spine (sacro-coxitis, spondylitis).

The most rational **treatment** for this condition consists in opening the fistulous tract by splitting it radially towards the anus into the rectum. A probe which leads through the fistula into the anus or rectum will show us the way.

The **technic** and **after-treatment** are the same as in adults.

For polypositas recti, see Tumors of the mucous membranes.

SECTION IV

INJURIES

BY

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In describing the surgery of accidents in children we must naturally omit all occupational injuries. We frequently observe, however, either through carelessness or unfortunate accidents, injuries in children which are closely connected with the occupation of either of their parents. Here we may mention the severe injuries of the hands which children acquire in unguarded moments on agricultural machines, bruises and cuts from feed-choppers, lacerations and contusions from threshing machines into which the hands of the children find their way, cuts from scythes and sickles, stab-wounds from all kinds of tools. All these furnish the daily work for the surgical wards of children's hospitals. To this we must further add the large number of burns and scalds which are connected with the family cooking and washing, and the severe burns from the setting on fire of the clothes when the children play near the lighted stove or with matches.

The injuries from foreign bodies form another chapter; these are caused by the habit of the child to put everything into its mouth and nose.

By far the largest number of injuries affect the bones and come from those accidents which are most common in the every-day life of the child: falling from the crib, from a chair, over the banister, young children stumbling at play or in a fight, falling off a tree, on the ice, from a sleigh, and an endless line of other possibilities which hardly a child escapes.

A. THE TREATMENT OF CUTS, LACERATIONS, AND BRUISES

This is done according to the general rules of asepsis and antisepsis. Cuts should be washed when possible in running water.

In letting smaller wounds bleed, naturally not too much, and in sucking out stab-wounds we possess an excellent preventive against infection. The flowing blood will with more certainty wash away the germs from the tissue-pockets than could be done with external or chemical measures.

With the use of antiseptics we must be very careful, especially with carbolic acid, which is the favorite amongst the public, because the child's system is very sensitive to it (necrosis).

After removing splinters, etc., we close the wound when we can assume that it is not infected; the suture is painted with tincture of iodine and over this it is advisable to paint some alcoholic resinous solution to prevent the spreading of the germs on the skin.

Splinters of glass and metal can be shown in the skiagram. In injuries with splinters of wood which have come in contact with the soil we must always think of tetanus, especially in regions where this is prevalent. Prophylactic injections of antitetanus serum, best intra- and perineurally, in the nerves supplying the injured part and injected proximally of the injury, can never do the children any harm and may save the physician from grave reproaches (in severe injuries intraspinal injection, lumbar puncture). [The foregoing applies also to injuries from powder and fireworks, especially the "Fourth of July" injuries which are still far too frequent in the United States.—THE TRANSLATOR.]

Soiled wounds of any size are cleansed and then dressed with balsam of Peru. At the same time we may try by protracted congestion to limit the infectious process and to shorten it and in some cases we can surely succeed. Attempts to prevent or remove infection by disinfecting and brisk rubbing out of the wound must be avoided. All these measures do a great deal more harm to the tissues of the edges of the wound than to the germs which are well hidden in the recesses of the lymph-spaces.

In larger lacerations, which are especially frequent on the hands, we must be as conservative as possible. Only those pieces which separate spontaneously are taken off at the line of demarcation; exposed and loose splinters of bone are removed, severed muscles, tendons, and nerves are united. More extensive primary plastic operations should be postponed on account of the danger of infection. The edges of the wound are covered with balsam of Peru, which acts as a disinfectant and also prevents putrefaction of the dead tissues. Continued congestion is applied to the injured limb and it is placed on a moderately warm thermophore. It is almost marvelous to find that tissues which had been considered as lost will recover under this treatment and to observe the power of regeneration of function of the youthful body.

In a child of two years the right wrist was cut through entirely by the knife of a feed-chopper except for a strip 1 cm. wide and a few mm. in thickness at the ulnar side; fortunately the ulnar artery, protected by the flexor ulnaris, was preserved in this strip. After uniting all tendons, nerves, and the skin, this hand, which at first was livid, recovered entirely under the treatment just described.

We must naturally employ every means to avoid permanent deformities and disturbances of function (proper posture on splints and treatment of fractures). Only when the danger of infection is passed do we attempt to improve the function by plastic surgery.

B. BURNS AND SCALDS

(Symptomatology, see Galewsky, Burns, vol. iv.)

Reflected heat as well as flames, hot solids, fluids and gases may have destructive action upon the tissues of the body, in most cases the skin and subcutaneous tissue are affected.

The *first degree of burn* (combustion erythematosa) is shown in the redness and swelling of the skin (insolation, scalding with water at 50° C.). The symptoms disappear after a few days, leaving increased pigmentation of the skin.

Treatment.—Mild ointments.

The *second degree* (combustio bullosa) shows blisters upon the skin besides the symptoms of the first degree which consist of a collection of liquid between the epidermis and corium. Severe pain is present, which increases when the corium is exposed after the blisters have broken or when the pieces of epidermis have been removed.

Treatment.—Opening the blisters, leaving, however, the epidermis for protection; soiled pieces of epidermis are removed; washing with sterile salt solution (.7 per cent.), or at most with some hydrogen peroxide (1 to 2 per cent.).

Small exposed parts of the corium are covered with sterile ointments (or with the inner membrane of an egg which has been taken out under aseptic precautions).

Ointments: lime water with olive oil, equal parts, and dermatol 10 per cent. Bardeleben's bismuth bandage or sterile powder dressings or talcum powder with 5 per cent. zinc oxide are useful.

In the *third degree* the skin is escharotic and the subcutaneous tissue is also affected (combustio escharotica). The slough demarcates from its surroundings during the process of healing and is cast off, and the consequent granulating surfaces heal, leaving large scars. If they should be extensive, these burns will cause severe general symptoms, rise of temperature, symptoms of poisoning (vomiting, convulsions), disturbances of consciousness (delirium, coma), lowering of the blood-pressure (small pulse, heart weakness). Large burns (more than one-third of the surface of the body) usually cause death during the first twenty-four hours with the above described symptoms and small children are especially sensitive. Even after the first symptoms have abated life is still threatened by nephritis, uræmic coma, thrombosis (duodenal ulcers).

The **primary treatment** must be symptomatic except for the temporary aseptic dressing: excitants, heart tonics, administration of liquids as hypodermoclysis or micro-clysmata (see Peritonitis).

After the primary dangers from shock, heart failure and nephritis have passed we try to prevent the extensive scars. As these large granulating surfaces rarely remain free from infection (pyocyaneus), we must refrain from extensive grafting upon the granulating tissues. We may considerably shorten the process of granulation by grafts, according to Thiersch, thus forming new islets from which epidermization advances.

FIG. 119.

Scar contraction after extensive burn. Child of six years. The burn was caused by the clothes catching fire from a candle. Burn of the third degree. Arm, forearm, and the adjoining part of the thorax were bare of skin. Treatment dermatol ointments, Bardeleben's bandage. Five weeks after the injury we started with Thiersch grafts; healed after two months. The persisting scar contractions were improved after everything had healed with large pedunculated skin grafts (nine months after injury).

The granulations are cleansed as much as possible with compresses moistened with salt solution and for some days they are brought to the level of the skin by the application of compressive bandages. Upon the granulations we transplant, without scraping, long narrow Thiersch grafts; to cover these we have found perforated pieces of protective silk soaked in oil to be best. Large and wide Thiersch grafts do not take hold well on account of the pus collecting underneath. Smaller Thiersch grafts also should be applied at several sessions. Narcosis is hardly necessary when we use local anaesthesia of the respective nerves, and a repeated light etherization is less dangerous than one long deep narcosis.

Large transplantations of skin should be left till later (Fig. 149), when scars have formed in place of the large granulating masses, because we can control the result much better with a clean freshly-made wound.

When we treat large granulating surfaces with ointments we must always remember to change the remedy from time to time during the healing, which takes many months, to avoid cumulative action. We were able to observe in one case of long-continued treatment with dermatol ointment a bismuth intoxication, which showed in affections of the mucous membranes, deposits of the metal on the teeth, and bismuth could be shown in the urine similar to an intoxication with mercury.

Freezing (congelatio) (see Galewsky, vol. iv) usually affects the most peripheral parts of the body of children (school children). We must here state that for a congelation a temperature at or below the freezing point is by no means necessary in weak children. A stay for any length of time in places which are not heated (10° to 12° C.), in boarding schools for instance, suffices to produce chilblains.

The different degrees of congelation are the same as in burns.

The **treatment** has to restore first of all in congelations of the first degree the tone of the blood-vessels (chilblains, perniones), hot baths, hot and cold baths alternately, massage, hot packs. For their prevention all constrictions should be avoided (big shoes, mittens). Local treatment consists in the application of ointments or astringents.

C. FOREIGN BODIES

The foreign bodies which are found in the accessible cavities of the body in children, with their diagnosis, prognosis, and treatment have been exhaustively described under the diseases of the respective organs— nose, trachea, bronchi. (E. Feer, Foreign bodies in the nose, vol. iii; E. Feer, Foreign bodies in the trachea and in the bronchi, vol. iii; D. Galatti, Foreign bodies in the larynx, vol. iii.)

The demonstration of these foreign bodies in the skiagram is of great surgical importance. Taking plates in the different planes we may be able to gain much valuable information as to their size and exact location, provided they are impervious to the Röntgen rays.

Foreign bodies in the trachea or in the bronchi may cause us considerable difficulty, but modern bronchoscopy through the mouth or tracheotomy will make even these accessible (v. Hacker).

Foreign bodies, such as pieces of bone, fish bones, buttons, coins, etc., will more frequently get stuck in the œsophagus. The impossibility to swallow or pains with it and difficulty in breathing from protrusion of the foreign body against the trachea are the most frequent symptoms, to which may be added that for mothers an important symptom is the

missing of the suspected article, which, however, may be unearthed from its hiding place in a corner of the room a few days later.

The skiagram usually gives us the necessary information about the nature, size and location of the foreign body.

A considerable number of instruments, coin-catchers, probangs, etc., have been constructed for their removal (Weiss, Kirmisson). Nowadays we will usually succeed with the œsophagoscope and with properly constructed instruments in removing foreign bodies, and only rarely will we have to resort to operative procedures (œsophagotomy).

The location of the foreign body will naturally determine the proper procedure in every individual case. In deep-lying ones we will have to do a gastrotomy, in higher ones an œsophagotomy either at the edge of the sternomastoid or in the median line, with or without opening the œsophagus (Hans, v. Hacker).

The *burning of the œsophagus with caustic solutions* deserves our special attention owing to its frequency in childhood (see Finkelstein, Œsophagitis corrosiva, vol. ii.) (Fig. 150).

The cicatricial stricture following it demands long-continued treatment with sounds. Early treatment (Bass) with sounds is dangerous. At first we order absolute rest, anodynes, rectal feeding or through a gastric fistula; only after three or four weeks may we begin our treatment with sounds. After the stricture has been made pervious for filiform sounds, we proceed to dilate it gradually with thicker ones. V. Hacker recommends introducing a tube down to the stricture and to fill the tube with filiform bougies; by careful probing one of these will find the right passage, but we must always remember the ampulla-like dilatations and the deep diverticula which are frequently found in the half-macerated ulcerations above the stricture, and that the wall separating it from the pleura may be extremely thin. Breaking through this wall will usually be followed within a short time by death from purulent pleurisy and pneumothorax. (By letting the patient swallow bismuth paste we may show the diverticula on the skiagram.)

Even after long-continued treatment with an œsophageal sound, at a time when the children have learned to introduce it themselves, a false passage or a diverticulum which had been deepened through the act of swallowing may perforate, because ulcers with a friable base form in the bottom of the diverticula.

We must, therefore, always remember the recommendation of v. Hacker, to make a gastric fistula whenever the introduction of the bougie is in the least difficult and institute from here endless retrograde bouginage.

Through the mouth we introduce the thread down to the gastric fistula and with this we run bougies, increasing in size, from the gastric

FIG. 150.

Ulcers at the edge of the
normal and injured mucous
membrane

Scar stricture

Extensive cicatrices

Stomach
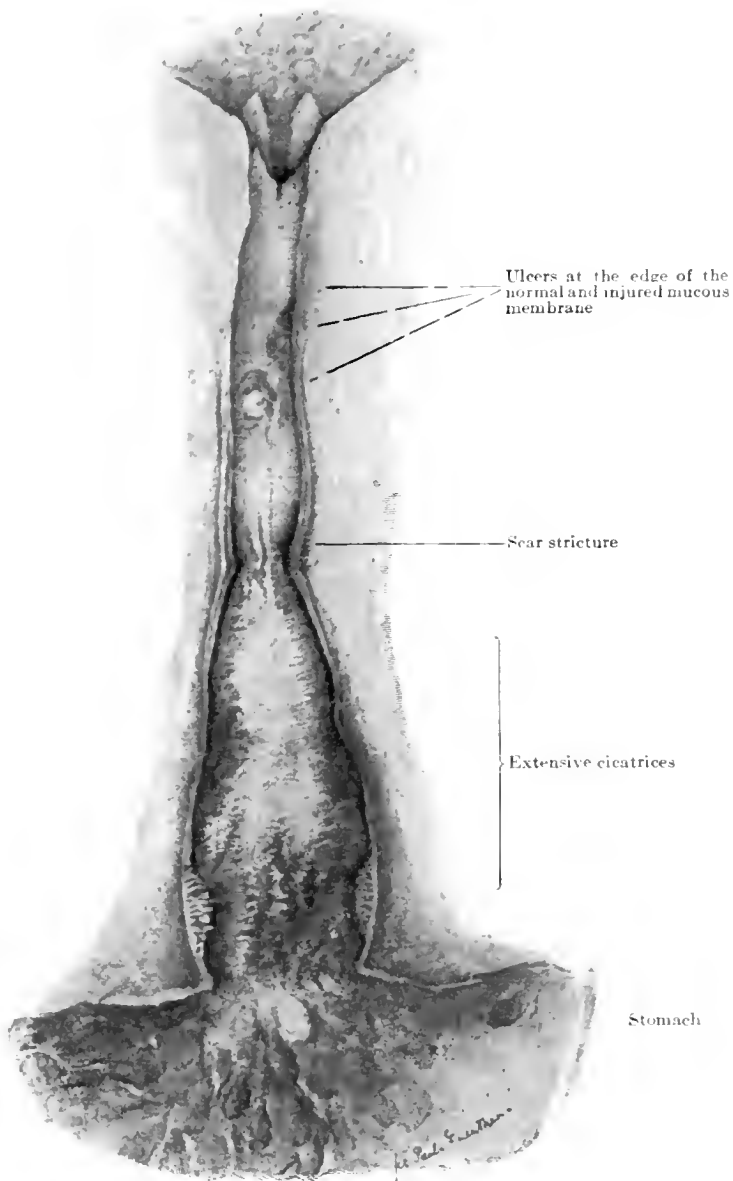
Callous circular caustic stricture of the œsophagus. Boy of thirteen years.

fistula, through the stricture without running any danger of perforating
a diverticulum. As soon as the dilatation is sufficient for the child to
swallow solid food, then the fistula, which had been made tubular accord-
ing to the advice of Witzel, closes quickly, and we can maintain the dila-
tation through the introduction of large bougies by the mouth (v. Hacker,

Lotheisen). This method is easier and safer than a difficult bouginage through the mouth, and we can also give these starved youngsters sufficient food through the gastric fistula and thus increase their strength.

The reports about fibrolysin are very contradictory; we personally have always waited with its administration until after the treatment with sounds, on account of the softening effect it is supposed to have on scar-tissues, and we have then used it in cycles of ten injections; we must confess, however, that we have never been able to notice any remarkable results from this treatment.

CONCRETIONS (STONES) OF THE KIDNEY, BLADDER, AND URINARY PASSAGES

(Symptomatology, see Langstein, vol. iv.)

These stones are found most frequently in children in the southern part of Hungary and in Russia, also (according to personal communication to the author) very frequently in India. Stones in the bladder occur mostly in boys, possibly on account of the long and narrow urethra.

In skiagraphy we possess a means of clearing these diagnoses which are often exceedingly difficult (stones in the kidney). Small friable concretions, however, do not show on the plate (Albers-Schönfeld).

Rovsing recommends in nephrolithiasis forced drink cures of three liters of distilled water daily (in adults), to be taken in single portions of 8 ounces; this will reduce the size of the stones. Alkaline mineral waters will make these grow from deposits. For larger stones in the kidney nephrotomy or nephrolithotomy (for these see surgical text-books), which are less dangerous than to carry concretions in one's body which may cause arrosions, infections of the substance of the kidney, and occlusion of the urinary passages.

The **diagnosis** of vesical stones in children is made easy by the bimanual palpation of the empty bladder through the rectum and the abdominal wall (see Appendicitis); otherwise cystoscopy, skiagraphy. Probing is frequently almost impossible in small boys, though this must be tried carefully. In these we shall also at first try a drink cure in small concretions. Litholapaxy, the ideal method in adults, cannot be used in children on account of the narrow urethra and long narcosis required. In large stones we will have to do a sectio alta (technic the same as in adults).

FOREIGN BODIES IN THE BLADDER AND URETHRA AND STRICTURES.

Tying the penis with hairs or threads may necessitate surgical interference (sectio alta, urethrotomia externa, boutonnière, circular resection of the urethra) when the foreign body cannot be removed with the aid of the cystoscope, or the stricture be dilated with bougies.

D. INJURIES TO THE SKELETON OF THE CHILD (FRACTURES)

These are usually caused by tumbles and falls. The external force, either the weight of the body in hitting or a force acting from outside (uterine muscles, obstetrical operations, muscular strength of others at play), will meet many conditions in the child's skeleton which differ materially from those met with in adults.

The bone is soft and elastic and it carries, especially in its ends, cartilaginous discs which give way to traction and bending. This is most likely the reason why we hardly ever observe luxations in children and why fractures are also rarer than in adults.

Falls down a whole flight of stairs, in which an adult would surely break several bones, can be sustained by the child often without suffering any damage.

The rigid lever of the adult is lifted and pushed more easily out of its socket by certain forces, while the young bone will bend and finally break at the place of the severest strain rather than being loosened from its joint.

Intraperiosteal fractures take the place of dislocations in children.

Another peculiarity of injuries to bones in children deserves special mention here, concerning which many erroneous views prevail in the text-books, namely, *epiphyseolysis* (loosening of the epiphyses).

As soon as a child had a break in the continuity of a bone near a joint we used to speak of epiphyseolysis. We find minute directions how to diagnose these; for instance, cartilaginous crepitation was said to indicate an epiphyseolysis. Still this was a mistake in the majority of cases, as among 1000 fractures which we had occasion to examine in the last ten years we were able to find only two true cases of epiphyseolysis.

One was in a girl of four years, whose leg had been caught in the wheel of a heavy truck, by which it was dragged. The leg was twisted out, we may say, and finally almost severed in the middle of the thigh by being run over by a heavily loaded wagon. After amputating, this being indispensable, we found besides the fracture in the diaphysis a loosening of the lower epiphysis of the femur.

The second case, in which we made a tentative diagnosis of loosening of the same epiphysis, happened in the following manner: A boy was caught up to his knee in a pile of logs and fell forwards. We made the diagnosis of epiphyseolysis because we were not able to find a line of fracture in the skiagram, but the nucleus of ossification in the epiphysis of the femur appeared to be dislocated and we noticed crepitation.

We will see from these two cases that it always requires tremendous force to produce this separation, and that it is more a tearing-off than a fracture. The anatomical conditions also favor this. The periosteum

is especially thick around the epiphyseal cartilages, so thick that Reiner has to cut it first to get a separation in the epiphyseal line in his operative epiphyseolysis.

We have personally gained the impression in more than one hundred epiphyseotomies (see Genu valgum) that the cuff of periosteum around the epiphysis is very strong and solid. From this it follows that when certain forces hit the bone it will break much sooner in the nearest weaker tissues, and these we find in the last formed osseous tissue of the metaphysis, which is still soft. We find the fractures in the neck of the humerus, the end of the radius, and the end of the femur as in adults, and skiagraphic diagnosis shows us that a piece of the metaphysis will always be united with the broken-off epiphysis, as has been stated before by French authors (Broca, Curtillier).

We can frequently observe hemorrhages into the epiphyseal zone without any tearing of the periosteum; and Trumpp reports one such case in which inflammatory processes followed the trauma.

Kirmisson, who wants to call every epiphyseolysis in and near the cartilaginous border "décollement épiphysaires," can give only very few clear cases. He observed that separation of the lower epiphysis of the femur happens in the same manner as we have described above "when children steal a ride on the back of a wagon or get their foot in a wheel, also when they fall forwards or sideways with the leg caught up to the condyles."

Epiphyseolysis at the upper end of the humerus is very rare in children. Only in pathologic conditions of the epiphyseal line, syphilis or suppuration in the joint, were these observed. In other cases of suspected epiphyseolysis the skiagram showed a fracture near the surgical or anatomical neck.

We rarely see an epiphyseolysis in injuries to the *elbow*. Here we usually get multiple fractures with overlapping of the lines of fracture, which may follow once in a while the complicated epiphyseal line in the elbow, at least partially.

Most frequently epiphyseolysis is reported in the *lower end of the radius*. Careful examination of the skiagrams in all our cases showed that we always had to deal with one of those typical fractures of the radius which are so frequent in adults; from falls upon the bent or stretched hand, in the shorter bone of the child the line of fracture will naturally be much nearer the epiphyseal line.

A true epiphyseolysis of the *upper end of the femur* is also very rare. In most cases the skiagram will show us a fracture in the neck of the femur, which may at times be near the epiphyseal line. Kirmisson collected some cases from the literature. Royal Whitman claims that coxa vara is often due to injuries in the epiphyseal line.

Taking all cases together, we will see that epiphyseolysis is of very rare occurrence and that only the skiagram gives us a right to speak of a true epiphyseolysis (two cases in 1000 fractures in our series).

In the cases of which we know, tremendous forces were always in action, and it was more of the nature of a pulling out or tearing off of the ligaments, which are closely united with the periosteum at the ends of the joints and which will sooner cause an avulsion of the epiphysis in the metaphysis than that its own elastic tissue should tear.

The **treatment** of epiphyseolysis is identical with that of intra-articular fractures.

We must now mention still another peculiarity of the bones of children, namely, the *incomplete and subperiosteal fractures*. The bone may break or crack inside the thick tight periosteum like a willow-switch cracks without tearing its bark (en bois vert) (Fig. 151a, Plate 16).

In some cases only one of two parallel bones (tibia and fibula) may be cracked without being bent or in the least displaced. Inside the periosteal tube of, let us say, the tibia may be an oblique fracture and still we will not be able to observe any displacement because the fibula is intact. Only a skiagram taken in different planes will show us the line of fracture and will explain why the child complained of pain at every step (Fig. 151b, Plate 16).

Hemorrhages into the very vascular epiphyseal zone are still more frequent; these we recognize by their dark shadow on the skiagram.

These peculiarities of the bones of children make the **diagnosis** quite difficult, the more so as all other signs may be lacking as long as the periosteum is intact—such as changes in shape, displacement, and crepitation. Only skiagraphy will enable us to recognize such injuries to the bones, which we were formerly only able to suspect from the pain and swelling.

We must always think of this as a possibility when children refuse for any length of time to use a limb, especially if they do not use it when we distract their attention from the injury or even when they are at play.

The **treatment** of these fractures does not differ in any way from that of the complete ones, for the simple reason that we usually change the incomplete fractures into complete ones when we correct the bend in order to avoid bad positions.

We do not advise to make this last a rule; if we should, for instance, be able to reduce the infracted bones in the forearm without tearing the periosteum, then we must naturally do so, because it will surely hasten recovery and keep down the formation of callus.

The subperiosteal fractures without dislocation and the epiphyseal hemorrhages require nothing more than fixation or keeping off the weight.

The *treatment of fractures* is in general much simpler and easier in children than it is in adults. The thick periosteum which is usually partially intact prevents any considerable dislocations, nor are the muscular tractions quite as strong and are, therefore, easier overcome than in adults. The tendency to heal is also much more intense in the child, so that we can as a rule count the time of union and of treatment one-third less than that of the adult. Only a simultaneous rachitis may interfere, and in its florid stage it may either shorten the time of healing or it may prevent healing altogether. The scar in the bone remains soft until the rachitis is cured, then only will it become solid.

The majority of the very angular rachitic deformities are most likely due to this and are the results of injuries to the bones which we call "*spontaneous fractures.*"

The less the power of resistance of the bone the smaller will be the force which is required to produce an infraction or a fracture (Fig. 152 and Fig. 153, Plate 14). A slight push, a jump, even a sudden strong contraction of a muscle will suffice to break completely the bone which is already bent.

Any process which softens the bone will have this effect: rachitis, osteopsathyrosis, osteomalacia, atrophy of the bone through disuse (in paralyses and inflammations), and finally that condition of brittleness of the bones which we call osteogenesis imperfecta and by which the number of fractures in one individual may mount up to incredible figures.

I. TOPOGRAPHY AND SYMPTOMATOLOGY

We will treat only of those fractures which are especially frequent in children, and in this connection we shall also mention those dislocations which are occasionally observed in children associated with fractures.

1. *Fractures of the Skull*

It requires great force to fracture the very elastic bones of the skull, for as long as the fontanelles are open the cranial bones, owing to their elasticity, give way to the impact of the frequent falls.

We have lately observed a number of intrapartum cranial fractures; in one of these we proved at postmortem that our diagnosis of "separation of a cortical lamella of the parietal bone" was correct; in another case we removed a piece of the occiput which was lying in a suppurating cephalhæmatoma like a sequestrum.

Falls upon some sharp edge, a blow, etc., on the soft, and sometimes rachitic, skulls of small children will be followed by large hæmatomata, after absorption of which we will observe sometimes more or less deep impressions of the cranial capsule. (Guard against mistaking the bony wall (periosteal swelling) in hæmatoma for a fracture.)

PLATE 14.

Fig. 151a.

Fig. 151b.

FIG. 151a.—Incomplete fracture of both bones in the forearm (child of five years), caused from fall in running. No dislocation, no crepitation, only a slight angular bend to be felt. Redressement, Dummreicher splint. Union in two weeks.

FIG. 151b.—Subperiosteal oblique fracture of the tibia (child of five and one-half years), caused by direct force (falling of a piece of lumber upon the leg). No displacement, no swelling, only pain on pressure locally. Inability to walk. Plaster cast without padding, well moulded over the condyle of the tibia. Union in three weeks.

Fig. 153

Fig. 152

FIG. 152.—Incomplete fracture of the femur in a very rachitic child of three years. Etiology unknown. Only symptom, pain on pressure, angular exaggeration of physiologic curvature. Extension with permanent fixation; dismissed with external hook-splint (see Fig. 167d).

FIG. 153.—Old ununited fracture of the tibia, etiology unknown, in a rachitic child of eight years. Operation, freshening and implantation of the ends. Plaster cast. Union in six weeks.

We were also able to observe at times depressions, the history of which told of their being recent, which were without reaction, swelling, or pain, and which most resembled a place in a celluloid ball which had been pushed in.

The cranial fractures of older children with the symptoms of *commotio cerebri*, and the typical bleeding from the mouth and ears in fractures of the base, do not differ from the same injuries in adults as to their cause or their symptoms.

2. *Fractures of Vertebræ and Ribs*

The vertebræ and ribs in children are well protected against fractures owing to their considerable elasticity, and only tremendous forces will fracture them when other injuries are to be found.

3. *Fracture of the Clavicle*

This is extremely frequent in children (about 30 per cent. of all fractures), thus taking the same place as dislocation in the shoulder in adults. It is caused by the same mechanism (fall upon the outstretched hand or the shoulder), the impact being transmitted to the clavicle and causing an infraction at the weakest point, usually at the junction of the middle and outer third of the bone.

Sometimes we will have only an infraction, with very little dislocation. In complete fracture we observe much pain and a lowering of the shoulder; the arm cannot be raised above the horizontal without pain. This is frequently the only symptom in subperiosteal fractures. Palpation of the clavicle reveals a place which is especially tender and swollen. Crepitation and abnormal motion may be lacking.

Fracture of the clavicle may also be found in the newborn after difficult labor (differential diagnosis from Parrot's paralysis, birth-paralysis). (See Fractures in Infants, Plate 19.)

4. *Fractures of the Humerus*

In rare cases and in older children we will observe

(a) FRACTURE AT THE UPPER END OF THE HUMERUS

at the surgical neck; this is usually a fracture from abduction from direct force (blow or fall upon the shoulder).

The short upper fragment is rotated outward by the supraspinatus, infraspinatus and teres minor muscles, while the lower fragment is pulled inward by the pectoralis and latissimus dorsi muscles, and elevated by the deltoid muscle, so that the arm appears to be in adduction, the same as in the typical dislocation in the shoulder. But the abnormal motility, crepitation, and palpation in the axilla and of the socket will explain the condition even without a skiagram (Fig. 154, Plate 15).

A simple dislocation of the shoulder-joint is extremely rare in children, and in apparent dislocation we must always think of this fracture and look for the torn-off head in the socket.

(b) THE FRACTURES OF THE DIAPHYSIS OF THE HUMERI

These are especially frequent in the new-born and are caused by muscular action and intrapartum manipulations. The fracture is usually transverse, about the middle of the diaphysis (slight dislocation) (Fig. 165a, Plate 19).

Occasionally we observe similar greenstick-fractures in young infants (rickets). In older children we find more frequently the oblique fractures, as in adults.

The most important symptoms are loss of function, well-localized pain, the bending in incomplete fractures, the abnormal motility and crepitation in complete ones (shortening). The amount of dislocation depends upon the site of the fracture or upon the change in muscular action from the separation.

(c) FRACTURES OF THE LOWER END OF THE HUMERUS (ELBOW)

These are of great importance in children and occur in about 20 per cent. of all fractures.

The numerous epiphyseal lines cause the structure of the newly-formed bone to be more porous in this locality, and therefore more exposed to dislocation and separation, because the periosteum which otherwise protects the cartilaginous epiphyses is lacking inside the joint.

The variations of fractures which we observe in this locality are very numerous, depending upon the mechanism of the fracture and upon the strength of the ligaments, which latter are better able to withstand the attacking force than the bone and therefore lead to a tearing out of their insertions.

The different positions of the arm, as, for instance, in falling, and the varying stages of ossification form another differentiating factor.

(1) Fractura Supracondylica

This is more frequent in older children, who are exposed to more severe injuries, and in whom the different parts of the end of the humerus are better united. The most frequent cause is a fall from a considerable height upon the hand with the elbow extended (Figs. 155a, 155b, Plate 15). In adults and older children the same injury will cause a backward luxation of the forearm in the elbow-joint. In children with flexible bones this fracture takes its place. The bone usually breaks obliquely, more rarely transversely, the upper fragment is forced against the skin and perforates it if the force causing the injury is considerable. The lower fragment is dislocated upward and backward by the traction of

PLATE 15.

Fig. 154.—Fracture at upper end of humerus. Fracture of the metaphysis in a boy of six and one-half years, caused by a fall from a wagon. The lower fragment is adducted by traction of the pectoralis and latissimus dorsi muscles. Bardenheuer's extension for twelve days, then ambulatory extension for fourteen days (1–2 lbs.). See Fig. 170.

Fig. 155a.—Fractura supracondylica (boy of twelve years).

Fig. 155b.—Case 155a, after reduction and cure.

Caused by fall from high horizontal bar upon the stretched-out arm. The forearm, together with the broken-off joint of the humerus, is rotated inwards almost 180°, this we can see by comparing it with Fig. 155b. Reduction Bardenheuer's extension at right angle for seven days (traction at the forearm), then daily changing extreme position. Cured in four weeks with perfect function.

the triceps. In some rare cases of falls upon the flexed elbow the upper
end may be dislocated backward, when the line of fracture has the
opposite direction.

Examination may be quite difficult when there is much swelling
and hemorrhage, especially so because in small children we cannot count
upon subjective symptoms. Usually the olecranon appears to be dis-
located upward and backward, but its point is found in a straight line
with both epicondyles the same as it is normally, while in luxation
it is found considerably above this line. Attempts at motion show
abnormal motility (even sideways) of the broken-off lower end of the
humerus. If we have no X-ray apparatus handy we will have to use
light narcosis with ether in unruly children. In small children we will
usually observe an intra-articular fracture (Figs. 156, 157, 158, Plate 16).

Of these the most frequent are:

(2) Separation of the External Condyle and Epicondyle

In falling upon the palm of the hand and with the force acting
somewhat obliquely, the impetus of the radius may tear off the external
condyle. Kirmisson explains the frequency of this by the broad surface
which this bone offers, and also by the delayed ossification of the external
condyle compared with the internal one. The torn-off piece of bone is
still hanging by the intact periosteum, appears higher, and is twisted
around in some cases and may be dislocated in any direction.

Should the epicondyle also be affected and the lateral ligament be
torn off, then this fracture may be combined with a sideways dislocation
of the joint.

The fracture may also extend into the trochlea, tearing this off,
thus causing a picture similar to that found in the higher, supracondylar
fractures (transverse intra-articular fracture) (Figs. 157, 158, Plate 16)
or separation of the condyles only (T-fracture). In still other variations
the part of the joint formed by the bones of the forearm may also be
destroyed.

In some rare cases of direct injury, such as a fall upon the internal
condyle, it may be broken off alone or with the trochlea; but these cases
as well as fractures of the olecranon and of the head of the radius are
much rarer in children.

The **diagnosis** in these cases is quite difficult, especially without ski-
agraphy. Painful motion in the elbow-joint is common to all these frac-
tures. The joint is always swollen, and filled with blood except in the
extra-articular avulsions. Motion in the joint is painful and limited (ab-
normal motility, occasional interposition of the separated piece of bone,
crepitation). Should either complete or incomplete dislocations be joined
to these fractures, then the deformity will be still more pronounced.

The total or incomplete backward dislocation in the elbow-joint is generally seen in later childhood. In smaller children it is at least always accompanied by the separation of one or both condyles (Figs. 157, 158, Plate 16). The diagnosis can be made from the changed position of the olecranon in relation to the condyles and from the elastic fixation, in which the luxation is held by the contraction of the muscles.

Of the sideways dislocations, which are usually accompanied by separation of the epicondyles, the isolated dislocations of the radius outward and upward interest us most. They usually arise after the tearing-off or at least after severe injury to the ligamentum annulare (Fig. 158, Plate 16). Kirmisson and other French surgeons state that this last, and especially the incomplete dislocation forward, may be caused by a strong pulling on the hand. (Lifting up or pulling by one arm by the nurse-girl.) The hand is held in painful pronation (*pronation douloureuse*). Kirmisson's explanation is that we do not really have a separation of the annular ligament, but only an abnormal stretching, which permits a partial slipping through of the head of the radius which makes a frequent recurrence of this condition possible (*derangement interne*).

5. *The Flexion-fracture of both Bones in the Forearm*

This comprises about 10 per cent. of fractures in children. It is usually only a flexion "*en bois vert*," and it is especially frequent in rachitic children. A fall upon the outstretched or flexed hand, a blow upon the forearm, even a propping up upon the arm, suffices to cause this fracture by increasing the natural curvature above the limit (Fig. 151a, Plate 16).

Usually both bones are fractured or infracted; rarely only one. The most frequent are the isolated fractures of the ulna with dislocation of the head of the radius. These deserve special mention and are caused by a direct force.

The diagnosis of these fractures is not difficult, especially when we remember the possibility of a subperiosteal injury, which we can recognize in children by the localized swelling and pain, and only rarely will we observe considerable dislocation (Fig. 151a, Plate 14).

6. *The Fractures at the Lower End of the Radius*

Though these are quite frequent in adults, they occur much more rarely in children. In smaller children the flexion-fractures of both bones of the forearm will take their place, and only in older children will the neck of the radius break near the epiphyseal line (Fig. 159, Plate 16).

The skiagram shows that we always have to deal with a fracture more or less near to the epiphyseal line which causes that peculiar swelling and dislocation known as silver-fork position of the hand. In

PLATE 16.

Fig. 156.—Separation of the external condyle. Fall upon the outstretched arm with the hand flexed dorsally (observation of the mother) in a child of four years. The separated condyle, which is hanging by a piece of periosteum which can be clearly recognized, is turned and twisted upward and outward; by pressure from the side it can be replaced. Treatment, rectangular fixation, then changing of bandages in extreme positions. Union in three weeks, only full extension not yet possible spontaneously.

Fig. 157.—Fractura supracondylica intra-articularis in a child of four years. Fall over banister. The inner condyle is torn off, together with a large piece of the diaphysis, and dislocated upwards, inwards, and backwards, mobility of the arm sideways and ulnar dislocation of the forearm. Treatment same as Fig. 156.

Fig. 158.—Separation of the condyles with total ulnar dislocation of the forearm in a child of three years, caused by a fall from a chair. Abnormal motility sideways, tremendous hemorrhage. Treatment same as Fig. 156.

Fig. 159.—Fractura radii child of three years, caused by a fall upon the dorsally flexed hand, with typical dislocation radially and dorsally of the separated piece. Treatment, splint with volar and ulnar flexion.

small children an X-ray diagnosis is difficult owing to the wide cartilaginous zone; but as the epiphyseal line itself does not ossify before the eighteenth year, it might be that in later childhood, when the epiphyseal line is narrow, an epiphyseolysis would be more frequent. We know, however, from clinical experience that the opposite happens, and we observe here almost always true fractures. Occasionally we may observe cases without dislocation of the fractured ends, and these we may mistake for a distortion of the hand. Dislocation of the hand is, however, so extremely rare that we have hardly any right to consider it, and in every case of swelling at the wrist of any size it will be better for both patient and doctor to institute the same treatment that would be used for a fracture of the radius, especially when we cannot make use of skiagraphy and when we cannot find any abnormal motion or crepitation owing to the thick cuff of periosteum in children. This precaution will save the patient some deformities which are very difficult to correct, and it will save the physician from reproach.

7. *Fractures of the Metacarpus*

These as well as fractures of the phalanges are rare and are caused by direct force.

[The above is meant for Germany, where baseball is not played. In the United States, where baseball is the national game and where boys begin to play almost as soon as they can walk, the direct force is given by the solid ball, which is pitched with great strength, and fractures of the end-phalanges of the fingers are of very frequent occurrence. They are still too often diagnosed as luxations, though the skiagram would readily inform us about the true nature of the injury and we would then be able to prevent the deformities which are now as much a sign of a young man's prowess in America as the scarred faces of the German students.—THE TRANSLATOR.]

8. *Fractures of the Pelvis*

Fractures of the pelvis are caused by the action of strong forces, as a fall from great height or the falling of heavy articles upon the pelvis. In one case a fracture of the pelvis had been caused by a heavy packing box falling sideways against the pelvis of a child of four years. The bone was fractured at its thinnest place, the pubic spine, and at the junction of the descending ramus of the pubis with the ascending ramus of the ischium. It was quite characteristic that a piece of bone adhered to the symphysis, the same as happens in "epiphyseal fractures," and that the symphysis was not loosened (Fig. 160, Plate 17). The acetabulum had also been compressed by the force which had acted diagonally, so that the head of the femur seemed to be forced out. The dislocation

of the bones had loosened the connection of the genito-urinary tract with the bone and the necrotic pieces of bone appeared from this suppurating cloaca. Owing to the wonderful power of regeneration of children the acetabulum was almost reformed within the year, without shortening. Except for a prominent scar in front of the urethral orifice the vulva was normal. This favorable result must be regarded as exceptional; usually these fractures are complicated by severe injuries to the intestines, which will be a frequent cause of their fatal ending (peritonitis).

9. *Fractures of the Femur*

Fractures of the femur are very frequent in children and comprise about 30 per cent. of all fractures. They are usually oblique fractures in the middle of the diaphysis. Through falls from great heights, but still more frequently in sport, especially coasting in winter, we will see them caused either by direct or by indirect force. Transverse fractures will prevail over the spiral ones in small children, especially those with rickets, and also the nearer the fracture comes to the end of the femur (Fig. 161, Plate 17; Fig. 167, Plate 20). Infractions are here more rarely observed, partly on account of the strength of the causative force, partly on account of the strong muscles which will here soon cause a total dislocation (Fig. 152, Plate 11).

Fracture of the femur is one of the most frequent fractures in the new-born. In breech-presentations and in difficult or unskilful obstetrical operations it is frequently a direct consequence of labor and is generally a complete fracture.

The dislocation corresponds to the height of the fracture; in the upper third abduction of the upper end, adduction of the lower one; in the lower third the dislocation will be very slight, especially in transverse fractures. Only in the very rare supracondylar fractures will the traction of the gastrocnemic cause a rotation of the peripheral piece around its frontal axis, and by its pushing against the popliteal space it may either tear or compress the popliteal artery, which here lies close to the bone (see epiphyseolysis) (Fig. 162, Plate 18). We should always think of these fractures when we apply a short plaster cast to the hip which does not quite reach to the knee; should the patient fall, he will be liable to break the bone against the hard edge of the cast. For this reason every splint should reach down to the condyles and the parents should be warned to be careful when the child begins to walk.

10. *Fractures in the Neck of the Femur*

Formerly these were considered to be extremely rare in children, but the study of coxa vara traumatica has shown their frequency (Hoffa, Whitman, Sprengel). Partial epiphyseolysis is also said to occur and

PLATE 17.

Fig. 160.—Fracture of the pelvis (six months after the accident in a girl of six years). In the fractured right half of the pelvis we miss the horizontal and the ascending branch of the pubic bone, which had been torn off and later discharged. The head of the femur had been forced out of the acetabulum, and it has now (after six months) found a support on a roof-shaped, newly formed bone. The adduction was corrected later.

Fig. 161. Fractura femoris (girl of eight years). Typical oblique fracture, abduction of the upper fragment, adduction of the lower fragment. Shortening of 2.5 cm. Treatment, extension dressing for three days, then plaster cast with extension for five weeks.

to cause dislocation of the neck of the femur later. They are most frequent in the first part of the second decade; at this time the epiphyseal line is very narrow, and we will be more liable to have an interosseal fracture than a separation of the bone in the epiphysis. In four cases in all we saw only one case of interosseal separation of the neck of the femur (Fig. 163, Plate 18).

The diagnosis of fracture of the diaphysis of the femur can usually be made by inspection. Shortening of the limb, change of its shape, dislocation, and crepitation will make it positive.

In fractures of the neck the sudden beginning of the symptoms, the lack of motion of the head, the ascending of the trochanter, the outward rotation of the foot, and perhaps crepitation may be used in the differential diagnosis against other affections of the hip. Incomplete infractions may be ascertained on the skiagram.

11. *Fractures of the Bones of the Leg and Foot*

[Fractures of the upper end of the tibia and interarticular fractures and dislocations in the knee-joint are very rare in children. As the patella remains cartilaginous for a long time, we will not observe fractures of the patella in children and their place is taken by the separation of the apophysis tibiæ (baseball).—THE TRANSLATOR.]

Hemorrhages and incomplete fractures at the apophysis tibiæ are relatively frequent. This serves for the insertion of the tendon of the patella and is ossified from its own centre; these may lead us to suspect an osteomyelitic process. They cause the child severe and long-continued pain when extending the leg (Alsberg, Schlatter).

The isolated fractures of the tibia are rarer in children than in adults. The fractures of the ankle are almost entirely lacking (see Subperiosteal Fractures) (Fig. 151b, Plate 14).

Only from strong impact do we observe fracture of both bones (Fig. 164, Plate 18) (from being run over by a rig or automobile, falling after one leg had been caught, blow); sometimes the very elastic fibula will escape, and the tibia will then show a subperiosteal oblique fracture, which we can only find, even on the skiagram, after we have taken it in different planes. Slight periosteal swelling, local tenderness, and the impossibility of stepping upon the leg must make us suspect this condition.

Isolated fractures of the fibula are so rare in children as to deserve hardly any mention. The same may be said of the fractures and the luxations of the bones of the foot. Of fractures of the metatarsi we have only seen those in the first one from direct force, also in one case from an involuntary jump from a considerable height.

II. TREATMENT AND PROGNOSIS OF FRACTURES

In children we must frequently apply different means of treatment than in adults, and we will therefore confine ourselves more, in the following, to give the necessary or desirable differences from the treatment of fractures in the adult, rather than go into the details of the treatment of every single fracture.

(a) *The Fractures in Infants*

This branch of the treatment of fractures has heretofore been sorely neglected. The tender skin of the infant, its round agile body, its movable cover of fat which envelops the soft bones, offer considerable difficulties to an exact therapy, to which is added the difficulty of keeping any complicated dressings clean.

Most text-books only allude to some possible modifications of the bandages and thus hardly aid the practitioner when he has to deal with a birth-injury, for instance.

The upper arm, the clavicle, and the thigh are the favorite locations of obstetrical fractures.

On the arm we usually find a transverse fracture in the middle of the diaphysis (Fig. 165a, Plate 19).

The usual mode of treatment is to place the arm alongside the body in extension; also shoulder bandages (Desault, Velpeau) are used. We had also tried to place the arm in a longitudinal splint, but all our efforts were in vain owing to the shortness of the arm and the soft motile body which did not offer much hold to the splints. Placing the arm upon a triangular splint is by no means easy with an arm only a few centimetres in length; nor is permanent extension an easy procedure in infants, as the little arm is hard to grasp and the fingers swell quite readily.

Nowadays we fix the arm flexed at the elbow to a right angle in horizontal elevation upon a longitudinal splint, using the sound arm for support (Fig. 165b, Plate 19). The whole splint runs behind the back from one hand to the other, thus holding the fracture in sufficient fixation. The child will soon be accustomed to this position and can be carried around in the splint. Should a dislocation threaten, then we can combine this method with elastic or weight extension.

In fractures of the clavicle (Fig. 166a, Plate 19) we use a similar splint, with the difference that not the upper arm but the forearm is fixed upon it in rectangular flexion. By rotating the shoulder outward and by tension upon the anterior capsule of the shoulder-joint the fractured ends are pulled apart and angular union (from drooping of the shoulders) is prevented (Fig. 166b, Plate 19).

PLATE 18.
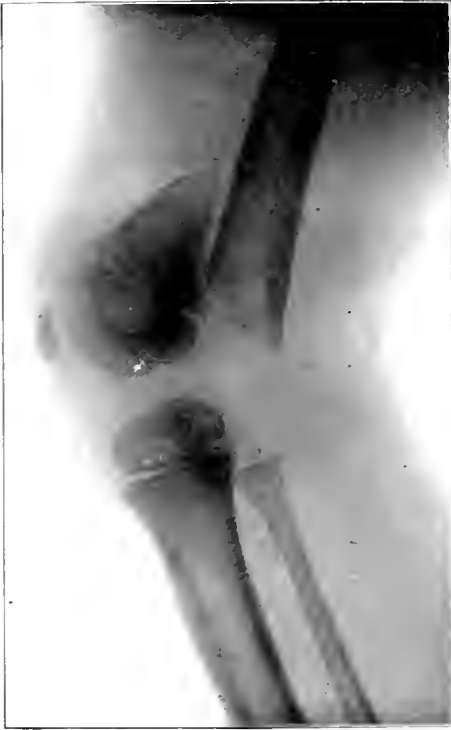
FIG. 162.

FIG. 162.—Fractura supracondylica (boy of eleven years). Fall from horizontal bar upon the flexed knee. Oblique separation of the metaphysis. The line of fracture is mostly inside the joint; considerable hemorrhage, the extended capsule and the adjoining bursa under the quadriceps are filled with blood. Abnormal motility, crepitation, shortening. Treatment, reposition in narcosis. Extension in flexion; levering the proximal fragment forward by counter-extension. Motion after two weeks.

FIG. 163. Fractura colli femoris in replaced position before applying the bandage. Girl of eleven years. Fall from tree. The line of fracture runs intracapsularly. The leg was in outward rotation, slight shortening, impossibility to step upon it, pain on passive motions. Treatment, plaster cast with inward rotation and abduction for eight weeks. stirrup.

FIG. 164.—Fractura tibiae et fibulae (boy of nine years), from being run over by bobsleigh. Abnormal motility, crepitation. Treatment, well-moulded plaster cast after three days, when swelling had gone down. Union in three weeks.

FIG. 164.

FIG. 163.

We make use of a similar principle in the fractures of the femur.

Here also do we make use of the sound limb for support (Figs. 167a, 167b, 167c, Plate 20).

Formerly we treated fractures of the femur in children in such a manner that the thigh was strongly flexed in the hip and the leg extended in the knee and so fixed to the body that the foot was placed over the shoulder of the sound side. Besides the inconvenience of thus encircling the whole body this kind of bandage does not prevent a permanent deformity of the leg.

We now take two iron hoops about $2\frac{1}{2}$ cm. wide and join them at one end on their flat surface with a rivet (Fig. 167b, Plate 20). The place of union corresponds to the end of the sternum. The legs are abducted and in this position the rods are moulded to the anterior surface of the legs, following the favorite position of the legs in infants (flexion in both hip- and knee-joints). To this splint both legs are fixed by bandages (Figs. 167b, 167c, Plate 20). The spreading helps to hold the splint in place and the elevation of the legs prevents soiling.

In older infants, who have a more resistant skin, we apply vertical suspension (Schede), which we can fix on any bed or go-cart with a hoop and two pulleys (Fig. 167c, Plate 20).

The question of the amount of weight for extension is easily answered: It should be heavy enough to just raise the buttock of the injured side from the bed, while the sound side still rests on the bed.

It is necessary to watch the tender skin carefully on account of the danger of bed-sores.

Combination with Bier's congestion is advisable, because this favors union of the bone, which is frequently delayed, especially in rachitic children, when we apply suspension (Deutschländer).

After two or three weeks we discontinue the suspension and dismiss the little patient with an external hook-splint (Fig. 167d, Plate 20). This is made of the same hoops as the hinged brace only about 5 or 10 cm. of its end is bent off at a right angle over its edge. This brace is moulded to the outside of the abducted leg, so that the hook-like end lies on the outside of the foot, and the straight end reaches up into the axilla. Strips of sheet-iron are fixed to it transversely to secure its position. Should a convex deformity of the femur threaten or the bones be very soft, we prefer the hinged splint or suspension for the after-treatment.

In this manner we succeed in curing our cases without much deformity, except in cases of rachitis, where the treatment of fractures in infants requires the greatest patience.

The **prognosis** of fractures in infants is always favorable. König observed that even considerable deformities caused by fractures dis-

appeared during growth (disappearance of the callus, new formation of bone in the axis of gravitation); only the so-called "hyperphysiologic flexions" of the foot leave an Achilles heel. Deformities in this region have always a tendency to progress.

In *older children* the treatment will approach nearer to that in adults, but at present, when there is still considerable discussion about the superiority of fixation bandages or functional treatment with extension, we should always keep in mind the peculiarities of childhood. The active temperament of children makes a protracted treatment in bed very difficult; the extension bandages require a great deal of watching and severity, which the children will at times learn to escape, thus making the result doubtful. We, therefore, prefer in fractures of the lower limbs well-moulded plaster casts in the form of bandages, in which we can easily combine extension and keeping off of the weight, if they are applied carefully.

On the upper limb we will require extension treatment in those cases which might suffer a dislocation or diminished function near the upper end of the humerus. As we have stated before, especially for the treatment with extension in children, admission into a hospital is mandatory; treatment at home is possible only when the parents are highly intelligent and when the physician can keep the patient under careful supervision and make daily calls. The complicated splints of former times are now supplanted by simpler measures, because the varying measurements in children would necessitate a large number of splints and thus a great outlay of money.

We must be especially careful with the *para-articular and intra-articular fractures.*

To obtain as good a function of the joint as possible is our principal object. We must adapt the separated pieces as carefully as possible, and place the joint in a position that would be most serviceable if the joint became ankylosed,—namely, in the shoulder, elevation; in the elbow, flexion; in the knee, extension; in the hip, abduction.

After a few days, as soon as the process of healing permits, we can dispense with the primary position in the bandage, and from now on we apply bandages in extreme positions which are changed daily (see Fracture of the Elbow). It is advisable to combine massage, electricity, active and passive motions with this treatment, always with the necessary caution that good anatomical repair, and especially the restitution of the best possible function, is our highest aim.

When small pieces of bone are broken off inside a joint, for instance, the elbow, then we will not be able to do much for its union in its original place, but by daily changing the extreme positions (flexion and extension) we will force it to attach itself in a position which will not interfere

PLATE 19.

FRACTURES IN INFANTS.

FIG. 165a.—Fracture of the humerus. Almost transverse, slight dislocation.
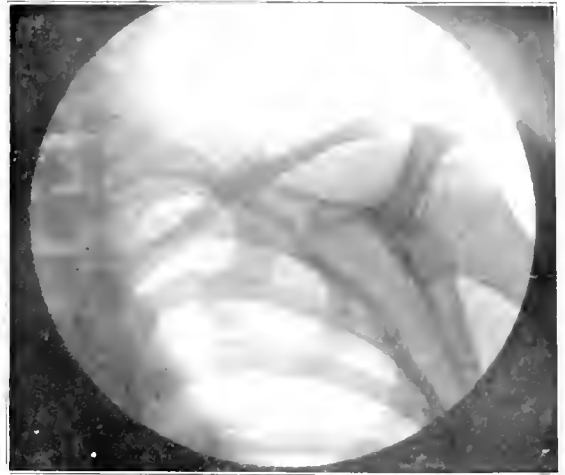
FIG. 166a.—Fracture of the clavicle (in its middle) with slight displacement of the fragments.

FIG. 165b.—High transverse splint. I, pattern; II, its use in fracture of the humerus.

FIG. 166b.—I, pattern; II, its use. By forcible outward rotation of the forearm we separate the fragments.

with the function. Should we not be able to succeed in this by manipulation, then opening of the joint and silver-wire suture of the bone will still be left us as the final means to repair the mechanism of the joint.

Badly healed bones demand rebreaking in those cases in which the deformity is in a place where it would give a bad prognosis; for instance, at the apex of physiological curvatures, or near a joint, when it interferes with the function of the joint.

Old ankyloses of joints after intra-articular fractures may be cured by osteoplastic resections (Bardenheuer, Payr, Hoffa). The reunion of the resected ends of the bones is prevented either through transplantation of pieces of cartilage (Hoffmann), or by the interposition of fat or flaps of fascia. We should always remember that in the upper extremity the greatest motility is desired, in the lower limb the greatest firmness. A shaky, unsafe knee-joint is less useful, in spite of its motility, than a fixed, stiff knee.

(b) *Cursory Survey of the Methods to be Recommended in the Treatment of Fractures in Children*

CRANIAL FRACTURES

These demand surgical interference only when the depression has damaged some part of the brain (focal symptoms). In other cases we must be very careful not to transform the subcutaneous fracture into an open one, because this would be quite dangerous, owing to the amount of detritus which is always present; therefore only the most conservative treatment should be employed.

Should focal symptoms be present, or should the cosmetic disfigurement be great, then an attempt should be made to elevate the depressed bone subcutaneously with a gimlet, and when this is not successful the fracture is exposed and the depression elevated from its edges.

FRACTURE OF THE CLAVICLE
(Fig. 166a, Plate 19.)

In small children the deep transverse splint is sufficient (Fig. 166b, Plate 19). In older children Sayre's adhesive plaster dressing or a hoop-iron splint should be employed, which fixes the forearm in rectangular flexion and outward rotation with the upper arm adducted, thus separating the fractured ends (Fig. 168a), or a similarly acting plaster splint according to Klapp. The chest-shoulder bandages (Velpeau, Dessault) are inappropriate, because they increase the faulty position and thus cause the formation of too much callus.

Time of union is about two weeks in young children, but longer in older children.

Fig. 168a —Pattern for making a hoop-iron splint for fracture of the clavicle. The splint, the back braces of which should reach down to the sacrum, is fastened to the body with adhesive plaster straps or with bandages.

Fig. 168b —Elevation splint for injuries in the shoulder-joint.

Fig. 169.
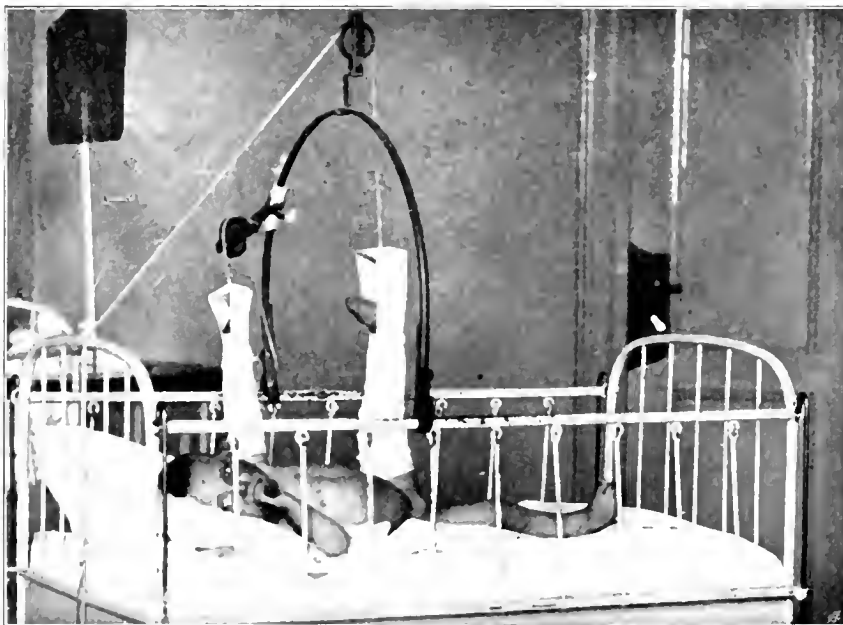
Extension bandages for fractures of the upper arm and thigh. Child of twenty months, run over by a carriage.

PLATE 20

FRACTURES IN INFANTS.

Fig. 167a.

Fig. 167b.

Fig. 167c.

Fig. 167a.—Fracture of the femur. Less oblique than in older children; considerable dislocation, crepitation, shortening.

Fig. 167b.—Hinged splint. Applied for demonstration. (The hinge, which is over the sternum, is covered by the shirt.

Fig. 167c.—The hinged splint fastened.

Fig. 167d.—External hooked splint. Showing its application.

Fig. 167e.—Extension bandage for fracture of the femur, fixed to baby carriage.

Fig. 167d.

Fig. 167e.

FRACTURES AT THE UPPER END OF THE HUMERUS
(Fig. 154, Plate 15.)

They require careful replacement. The peripheral end is placed in the direction of the short central piece which we cannot act upon. Close adaptation and Bardenheuer's extension can only be done under guidance of the skiagram (Fig. 169).

In injuries in the shoulder-joint we must always remember that the loss of elevation interferes most seriously with the function of the joint. In cases in which there is danger of limited motion, we must therefore always apply our bandages in elevation (see Tuberculosis of the Shoulder-joint).

An appropriate plaster splint (Fig. 121) or the hoop-iron splint shown in Fig. 168b will fix the arm in the right position.

FRACTURE IN THE DIAPHYSIS HUMERI
(Fig. 165a, Plate 19.)

In infants a high transverse splint (Fig. 165b, Plate 19), in older children treatment with extension according to Bardenheuer (Fig. 169), is indicated.

We allow our patients to get up after eight or ten days of Bardenheuer's extension, as soon as the callus is sufficiently developed to prevent dislocation. To guard against bending of the bone we make use of weight for extension, by letting a bag filled with 1 to 2 pounds of shot hang down from the hand of the free arm. With this we combine active and passive motions (according to Deutschländer). Time of union is from three to five weeks (Fig. 170).

FRACTURES OF THE LOWER END OF THE HUMERUS AND IN THE ELBOW-JOINT

These are very important as to treatment, because mistakes will leave conditions which it will be hard to correct.

The *fractura supracondylica* demands the most careful replacing of the lower end, which is bent backward; this will be especially difficult when it is twisted sideways as well (narcosis) (Fig. 155, Plate 15).

Fixation of the upper arm and traction upon the forearm, which is flexed to a right angle, may correct the deformity (control with the skiagram).

After preliminary treatment with extension, lasting about two weeks, a rectangular pasteboard splint according to v. Dummreicher will suffice, which will keep the arm in supination and to which extension by means of elastic traction may be added (Fig. 171).

Motion in the elbow should be started as soon as possible, even after the first week.

The *fractures in the elbow* (Figs. 156, 157, 158, Plate 16) are adapted as well as possible with a skiagram as control; the elbow is fixed for a few days upon a rectangular flanged splint according to v. Dummreicher (Fig. 171). After a week we attempt extension and take another skiagram to look for any possible dislocation of pieces of bone. Should extension be possible without any such dislocations, we then keep the arm for one day in this extended position, and flex it the next day again to

Fig. 171.
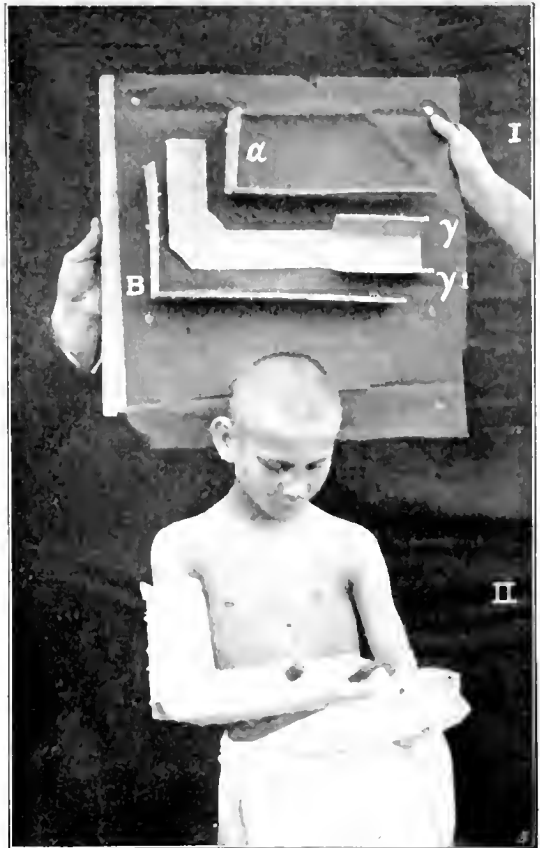
Fig. 170.

Fig. 170.—Movable extension treatment for the after-treatment of fracture of the humerus, and also to obtain full extension in the elbow-joint

Fig. 171.— V. Dummreicher's flanged splint. I. Pattern: the three pieces are cut out of pasteboard and placed so that those which are turned over their flat surface *a* and B come to lie within the flanges γ and γ₁, and are fixed there. First the supinated forearm is fixed in rectangular flexion in the elbow upon the padded main splint A, then the splint *a* is placed inside the flange γ, the splint B inside the flange γ₁, and fixed there; see II. The thumb and the last phalanges of the other fingers are left out of the bandage and must be moved freely.

a rectangular position, later to an acute-angular one; we change with these "extreme positions" daily from now on (Figs. 172a, 172b, Fig. 170).

After about three weeks, the parts will be united well enough to permit taking off the splint. The child must be able to touch the head, nose, mouth, and ears freely, and also to extend the arm almost fully before being dismissed from treatment. To obtain still further motion, we put the sound arm out of commission (bandage, tying together of

end of sleeve beyond the finger-tips). The use to which the arm is now put, in eating and playing, will provide further improvement of function; passive motions are also of help.

We were obliged to use silver wire in a few obstinate cases only. Small pieces of bone may be removed without any harm. In absolute ankylosis Bardenheuer's resection will offer the best results.

In *fractures of the forearm* (Fig. 151a, Plate 16) setting the frequent infraction flexions is of the greatest importance. This must be done fully even to over-correction, no matter if we thus produce a complete fracture or not. Splints have to be applied in such a way that the fore-

FIG. 172a.

FIG. 172b.

Extreme positions in the fracture of the elbow, prepared with bent movable pasteboard splints together with elastic traction.

arm is in supination (the patient must be able to look into his palm with the arm in rectangular flexion in the elbow).

When there is only slight dislocation of the fractured ends, then a dorsal plaster splint or the above-mentioned flanged splint of v. Dumm-reicher will suffice (Fig. 171). We are able to retain the correction by pieces of bandage or rolls of cotton. We should examine the patient frequently, at least once a week, because the faulty position is quite liable to return and the callus, which is at first as soft as wax, will still permit correction.

Union takes place in two to three weeks, during which time we must prevent the action of the biologically stronger pronators by enforcing supination; otherwise they will renew the deformity as long as the callus is soft, and when this hardens the angular bend will diminish the motion of supination.

FRACTURES OF THE RADIUS

(Fig. 159, Plate 16.)

These demand perfect adaptation and fixation in palmar as well as ulnar flexion of the hand (Fig. 173). A palmar splint, which is cut, according to the hand, out of pasteboard and which is thus flexed is

FIG. 173.

Mode of preparing a pasteboard-steel-wire splint for the treatment of fracture of the radius. I. Pattern: the splint cut according to the hand, which keeps it flexed toward the ulna; on the lower surface of the splint steel wires have been fastened with adhesive plaster to maintain the volar flexion—the motion of supination. II. The splint applied.

able to maintain this fixation: we can succeed in keeping up the curving of the splint by fixing bent steel wires to its under surface with adhesive plaster strips.

Time of union from two to three weeks.

Tearing apart of the ligamentum subcruentum will frequently leave a broadening of the wrist which can be influenced by transverse compression, provided the swelling is not too great.

FRACTURES IN THE PELVIS
(Fig. 160, Plate 17.)

FRACTURES OF THE NECK OF THE FEMUR
(Fig. 163, Plate 18.)

These require long-continued rest on account of severe complications. All other treatment depends upon the complications.

When fresh these should be treated with a carefully moulded plaster cast, which ensures adaptation of the fragments in extreme abduction and inward rotation.

We prefer the plaster cast to the treatment with extension, because this alone will ensure good results in restless children owing to the difficulty of influencing the deep-lying fragments (see Fixation of the ends in intertrochanteric osteotomies).

The plaster cast in abduction should be provided with a stirrup for walking and no weight should be allowed upon the fracture for eight weeks. Only by keeping off the weight for a long time can we avoid the possibility of a late bending of the neck of the femur into a coxa vara, especially since in this locality, more than in any other, osseous union may fail and only fibrous union take place, conditions which are caused by the difficulty in adapting the deep-lying fragments, by the poor nourishment of the neck, and also by the great demands made upon the femur.

Hoffa, also Whitman, advise extirpation of the loose head in old badly healed fractures of the neck. Lorenz is successful with his inversion; he tears through the insufficient scar under anaesthesia without cutting, leaves the head in the acetabulum and transposes the trochanter and the neck in abduction underneath the spine, thus giving in favorable cases a solid support upwards and a useful hip in abduction. This procedure is surely less dangerous than suture of the bone, which is always a severe operation owing to the opening of the large hip-joint.

FRACTURE OF THE THIGH
(Fig. 161, Plate 17; Fig. 162, Plate 18; Fig. 167a, Plate 20.)

In this fracture we must always be very careful in adapting the fractured ends and in avoiding shortening, which is always threatened (oblique fracture, strong muscles).

For the first few days, extension with heavy weights and counter-extension on the pelvis and ice to prevent late hemorrhage. After three or four days, when the swelling has subsided, we put on a well-fitting plaster cast which includes the pelvis and leg. It should fit especially well over the crests of the ilium, the tuberositas ischii, the condyli femoris and the patella and should be padded as little as possible (see

Coxitis splint); below the knee it should be loose so as not to interfere with extension and keeping off the weight (Fig. 174a). It reaches down to above the ankle and to it is fixed a stirrup; the ankles are held in a boot from which two or four straps run through slits in the plate of the stirrup to which they are fastened on the outside with buttons. Thus we can keep up the degree of extension which we had succeeded in getting upon

FIG. 174a.

FIG. 174b.

FIG. 174a.—Movable plaster cast in fracture of the femur with boot-extension. The cast is well moulded to the tuber ischii; the lower leg is heavily padded, so that we are able to extend it well in its loose case. To the cast is fitted a stirrup. Through slits in its plate go straps to the boot which maintain the extension.
FIG. 174b.—Celluloid-gauze cast for the ambulatory treatment of fracture of the thigh. Made according to the same principle as that in Fig. 174a.

the extension-table (control by marks upon the ankles with iodine). We can also make removable celluloid-steel-wire casts according to the same principles (Fig. 174b).

More radical measures, such as continuous extension with weights, nail-extension according to Codivilla-Steinmann, are not required in children because their muscles do not produce sufficient traction.

The results of the ambulatory treatment are better than of insufficiently watched extension in bed, and this latter is very hard upon children for any length of time.

We leave off the boot extension after two weeks and the stirrup after four weeks, so that the child can then step upon its foot. After the fifth week we shorten the cast to the knee, and take it off entirely after six weeks, provided the child is not afflicted with active rachitis. In small children up to three years we prefer the above-described suspension, combined with splints.

Fig. 175.
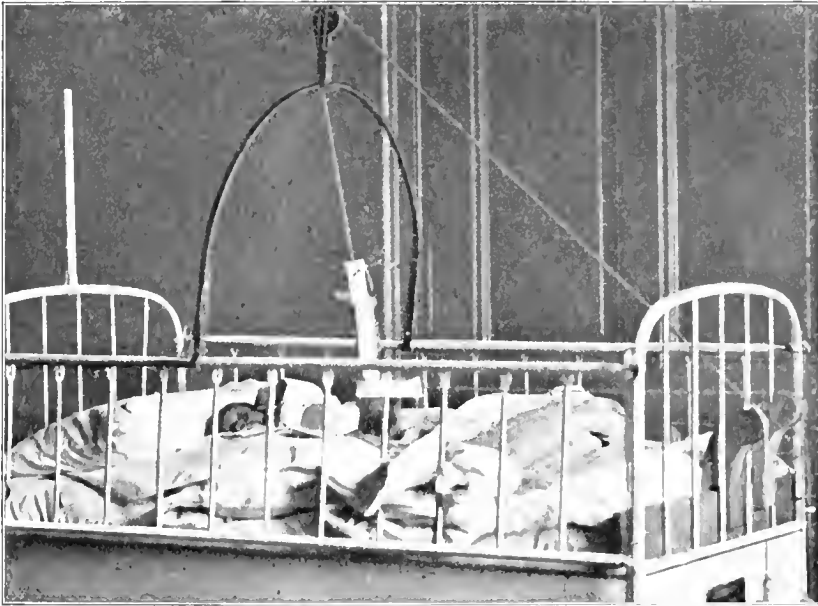
Suspension bandage in low fracture of the femur, with lateral traction to keep the proximal fragment in position.

The rarer fractures near the knee-joint are treated the same way. Naturally we will first have to replace the short lower fracture either by manipulation or by operation, and we may have to apply lateral traction to keep it in position (Fig. 175).

FRACTURE OF THE TIBIA
(Fig. 151b, Plate 16.)

This demands nothing more than exact fixation, which we get by applying a plaster cast over a stocking or one layer of flannel bandage; it must go from the toes to the tuberositas tibiæ, at which latter part it must be moulded very carefully. In a very few days the children will learn how to walk in this and the fracture is united in three weeks. The part enclosing the foot is first removed and if stepping does not cause any pain the rest of the cast may be removed after a few days.

The treatment of the isolated fracture of the fibula is similar, only still simpler.

In *fracture of both bones of the leg* (Fig. 164, Plate 18), and when we find considerable dislocation, the cast should be well moulded and should go to the tuber ischii to ensure permanent extension (see Fracture of the femur).

COMPLICATED FRACTURES

We try to transform these into simple ones with the greatest possible care. Trendelenburg circumcises the skin wound, removes the projecting fragment, and closes the wound by sutures. Further treatment is the same as in a simple fracture. In children we have not any reason for adopting radical measures. Balsam of Peru and sticky pastes are excellent means to prevent the infection from spreading, and Bier's congestion will help us to aid Nature's protective measures.

Delayed union is rarely observed in children except in rachitis. This latter demands waiting until its active stage is passed, also general and local treatment for the rachitis.

For imminent pseudarthrosis Bier's congestion and injection of blood into the periosteum are recommended; bone suture and plates are further measures to overcome delayed union (Lexer), though we will rarely have to use these owing to the strong power of repair in children (Fig. 153, Plate 11).

The other fractures which are rarer in childhood must be treated the same way as in adults.

SURGICAL MEASURES IN DISEASES OF A NERVOUS ORIGIN

BY

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Symptomotology, etc., of original diseases, see Zappert, vol. iv, and Knöpfelmacher, vol. i.

PARALYSES

ALL infectious processes, new-growths, and injuries which attack the nervous system, either at its centre or at the periphery, leave as after effects disturbances of the motor apparatus which are called paralyses or pareses, according to their intensity.

We will frequently observe grave secondary deformities, owing to the weight of the body, to the adaptation of the functions of the body to the faulty mechanism, and to the overaction of the healthy muscles and their nutritive shortening due to the deficiency of their antagonists and also the stretching of the paralyzed muscles which have lost their contractility. The complicated symptoms of these deformities will not always reveal their original etiology. Only careful analysis, together with the case-history of the patient, will give us an insight into the etiology and the original seat of the disease.

So far we do not possess a well-defined etiological treatment for the central processes, and we must, therefore, be satisfied with symptomatic treatment. We should always try to relieve the peripheral symptoms, and so long as the central organ resists our therapeutic attempts will we have to be content to limit our therapeutics to the periphery. The nearer we can get, however, to the real seat of the disease, the more rational will be our procedures and the more concentrated and effective will they be (see Tumors of brain and spinal cord, resections of roots).

According to the manner in which the muscles react to the injury to the nervous system, we differentiate between flaccid and spastic paralyses and pareses.

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A. FLACCID PARALYSES

The flaccid paralyses and pareses always indicate a lowering of energy of the muscle and are the result of a disturbance which has attacked either the muscle itself or its connection with its nerve-centre. Thus a partial interference with the conduction will cause a paresis, a complete one, however, a total paralysis in the muscles supplied.

Etiology and Prognosis of Treatment.—The flaccid paralysis varies considerably in importance according to its etiology. The connection between the end-apparatus of the nerve and the muscle may be disturbed by poisons or degenerative agents (neuritides, muscular dystrophies). Mechanical injuries may affect the peripheral nerve-conduction (fractures, injuries, compression from hemorrhages). The nerves which lie close to the bone or which run through bony canals often have to suffer from pressure or from fixation to their rigid neighborhood from scars (paralyses of the radial nerve in fractures of the humerus, paresis of the facial nerve in otitic processes).

The nearer the site of injury is to the centre the greater will be the paralyzed field, because this will then correspond to the injury of collective circuits (plexus paralyses). In flaccid paralyses of a central origin in children the seat will be usually found in the spinal cord (poliomyelitis, spinal meningitis, Landry's paralysis, progressive muscular atrophies of unknown etiology); tubercular and tumorous processes in the spinal canal and the brain are rarer causes of flaccid paralyses.

Before treating flaccid paralyses, we have to analyze most carefully their etiology and pathologic anatomy, because this will determine the prognosis.

Postdiphtheritic and neuritic flaccid paralyses give a favorable prognosis and we can determine their nature from the history and their clinical course. In these cases surgical interference would be a mistake, even treatment with apparatus is not absolutely necessary, and we must wait at least a sufficient time for spontaneous recovery. Improvement is possible even after years; the slight voluntary fibrillations which we were frequently able to observe from the beginning often increase from reconstruction of the muscular material to entire recovery of their power.

Prognostically opposite are the severe destructions and degenerations of a progressive character, though these are fortunately rarer (Landry's paralysis, progressive atrophy and dystrophies of the muscles). The rapid course will here render all surgical aid superfluous, but even in the more lingering extensive progressive muscular atrophies we must abstain from all radical surgical operations, and we shall only enable the child to move around as long as possible by supplying it with some sensible apparatus or chair to walk with, and thus make its existence

bearable until either a sure cessation has set in or until an attack upon the higher centres frustrates our efforts.

In poliomyelitic paralysis (Heine-Medin's disease) again things are different. Here we have to deal with an infectious inflammatory process in the anterior horns of the spinal cord, though we do not yet know the infecting agent which appears in epidemics. Reactive processes around the focus take place here the same as in infections in other organs; through the spreading of the infection, through collateral œdema, the function of the nerves will be disturbed over a large area (considerable peripheric spreading of the primary paralysis). The reactive and regenerative action of the protective apparatus of the body will wall in the infection, and either surmount it entirely at times or a focus of destruction will remain which is finally absorbed and replaced by a scar. In the course of some months the peripheral paralysis will either disappear entirely or the part corresponding to the scar will be finally paralyzed, though slight improvement may be observed even after years.

From this we will see that the time which has elapsed since the attack, as well as the condition of the affected muscle, will determine our further action.

Types of Treatment.—A permanent total flaccid paralysis is the indication of the death of the muscle. Absolute rest in the muscle, caused by the interruption of nervous conduction, condemns the muscle to atrophy from inactivity. It is gradually absorbed and turned into a shell of connective tissue from which there is no return. But as long as there is only the slightest trace of conduction in the nerve or transmission of electrical irritation through it or as long as the muscular fibres are stimulated through the muscle itself, so long will the sensitive end organs in the muscle remain active even after years of paralysis (Erb, Bardenheuer).

They can resume their activity as soon as we are able to remove the interruption in the nerve-current, either in the centre or at the periphery, and produce the necessary tension in the muscle or provide a new supply of nervous energy through operation. The muscle will re-form from the nuclei in the sarcolemma, the same as it does after neuritic paralyses and also normally under increased demand by hypertrophic growth.

We must, therefore, in cases of flaccid paralysis never desist from our stimulating treatment before either the muscle has re-formed spontaneously or we have finally decided to use other measures.

These measures consist in *operations on the nerves and tendons.*

When should these be performed?

It is surely a mistake to stop the treatment with electricity and massage after six months and to sit back and wait to see what Nature

will do for our patient. A slight improvement will usually return even after years, especially in those muscles which were still reacting, if only with the so-called "vermiform" fibrillations. But if these should not show the least improvement in the course of some months, or the reaction to stimulation decrease, or if increasing number of amperes be required to produce a minimal contraction, then we should not wait any longer before joining the diseased area to a healthy nerve supply provided we intend to do any nerve operation. The chances will only get less, especially if we stop stimulation of the ends of the nerves and the muscles and sacrifice them to entire involution.

On the other hand, should we decide on a tendon operation then it will be better to wait for one and a half or two years. By this time the body of the child will have adapted itself to existing conditions and it will try to get along with what it has (motilité supplée, according to Létiévant). From this we should take our cue for the plan of our operation. But we must always be careful to avoid the production of secondary deformities (contractions, overstretching of paretic muscles, pathologic dislocations). These we can avoid by posture, by simple splints made of plaster or celluloid, or by applying hinged braces, the paralyzed muscles being replaced by elastic traction. We counteract the overstretching by putting on weights or by the use of braces, thus preventing secondary deformities until our operation, or when the paralysis is extensive and operation impossible we give the patient a certain though limited use of his paralyzed limb.

Which paralyses are suited for *nerve-grafting*? Those in which one nerve-muscle area is involved either alone or nearly so while other surrounding nerves are either intact or only slightly affected. The nuclei for the different muscles in the spinal cord lie in different segments, but the centres for those muscles which are supplied by one common peripheral nerve-trunk are close together in the cord as well, and we therefore freqently observe separation of the paralyzed regions according to nerve areas.

When the whole of such an area is paralyzed, then nerve-grafting will be preferable to tendon-grafting, because we thus attack the paralysis nearer its centre and because we are able to restore the function of the whole of such an area, and this is especially important in the complicated motions of the upper limb, which could not be done successfully by the combined operation on different tendons (Spitzy, Bardenheuer, Stoffel).

Tendon-grafting is preferable in disseminated paralyses, in paralyses of single muscles of different groups, and it gives specially good results in paralyses in the lower limb, the type of motion in which is simple. It also offers more hope of success in paralyses of long stand-

ing which no longer show any sign of contractility in the muscles than would nerve-grafting, because we thus supplant dead material by a healthy one, and because we have hardly any right to expect a revival of the muscle which is dead and entirely degenerated. But even in some of these cases nerve-grafting will give remarkable results, so it can only be tried tentatively, and in case of failure tendon-grafting will be justified, because we are not permitted to sacrifice any of the healthy nerve-fibres by nerve operation in such doubtful cases.

Examination.—To devise a clear plan of procedure for operations we must carefully separate the paralyzed from the paretic and healthy material. In order to examine the condition of the single muscles we possess different methods.

We will be able to make a **tentative diagnosis** from the position of the limb, from its spontaneous motions, and from palpation of paralyzed and atrophic muscle. In older children the voluntary motions, which we let them carry out to the full extent of each single muscle, will instruct us in the best and easiest way about the extent of the deficiency. The impulse of the will is more exact than electrical stimulation. The surmounting of resistances will inform us about the weakening of the motor strength (fist pressure, resistance movements).

For these examinations we must possess an exact knowledge of the anatomy of the muscles and nerves.

Besides these methods we also possess an excellent means in *electro-diagnosis*, by which we can measure the irritability of the muscle through the muscle as well as through the nerve.

The time of the appearance of the opening and closing contractions has led to the formulation of Pflüger's law of contractions.

In the normal muscle the cathode closing contracture prevails over the anode closing contracture (C.C.C. > A.C.C.).

If the connection between the muscle and its end-nerve with the centre should be interrupted, and voluntary impulses are no longer transmitted, then the electrical irritability will also sink soon and instead of the normal short contractions we get the well-known sluggish slow vermiform fibrillations; the cathode closing contraction diminishes, the anode closing contraction prevails, A.C.C. > C.C.C. (reaction of degeneration). Finally, only a very slight anode closing contraction will be left, "but years may elapse before the galvanic irritability in the degenerated muscle dies out entirely" (Erb).

The points from which the muscle may be excited through the nerve are well known, and we are therefore able to determine by the quantity of the irritability by electro-diagnosis not only paralyses but pareses and lessened strength as well. This we can do easily in adults and also in older sensible children.

In smaller children the difficulties increase, owing to their restlessness, the smallness of surface, the movable panniculus adiposus, to such a degree that we would require a narcosis to be able to make a careful electrical examination, and we have therefore made use of the jerking away motions of small children against needle-pricks in attempting to develop a new method of examination, which is simpler, takes less time, and is also less dangerous for the child.

The Needle-prick Examination

Fig. 176a.

Fig. 176b.
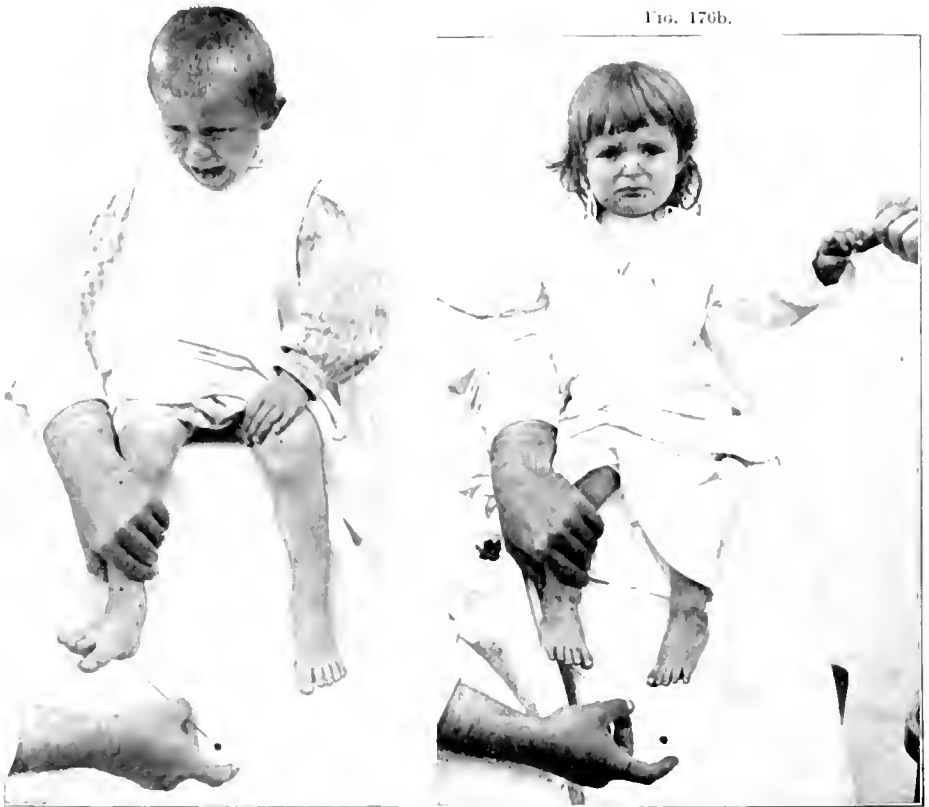
Needle-prick examination. Examination of the function of the peroneus brevis muscle. The needle is held obliquely to the outer edge of the foot, the left thumb of the examiner lies upon the tendon of the peroneal muscles. When the muscle is healthy, the outer edge of the foot will be elevated (Fig. 176a), when the muscle is paralyzed this will not happen (Fig. 176b).

(Figs. 176a, 176b; Figs. 177a, 177b).—Let us suppose the case of a paralysis in the peroneal muscles; the outer edge of the foot hangs down.

We now take a needle and slightly prick the child at the outer edge of the sound foot; then the child will quickly lift the edge of the foot to escape the needle. On the affected foot the action of the peroneals will be lacking; the child can lift the toes with the anterior tibialis muscle and try to keep these out of the way of the needle, but the elevation of the outer edge of the foot which alone would fulfil this purpose is lacking.

Examination of the quadriceps: Pricking the heel with the leg hanging down causes a contraction of the quadriceps as the jerking away motion. The rest of the limb must naturally be fixed.

With this method we will be able to carry out a more exact examination of the single motions and we will get better information about the condition of the muscle than we would by electrical examination, as the voluntary impulse gives a finer reaction of the muscle than the electrical one. The hand placed lightly upon the belly of the muscle or

Fig. 177a.　　　　　　　　　　　　　　　Fig. 177b.

Examination of the function of the quadriceps muscle. The needle is held in the plane of the expected response, perpendicularly to the arm of the lever, the left hand of the examiner is over the belly of the muscle Lifting of leg when the muscle is intact (Fig. 177a), and failing to lift it when the muscle is paralyzed (Fig. 177b).

upon its tendon can feel even very slight contractions, while the other hand attempts to produce the jerking away motion by the prick of the needle.

Outline of Treatment.—After we have carefully acquired an understanding of the spread and the intensity of the paralysis in the different muscles, we next proceed to formulate an exact plan of operation.

The first principle is to proceed as simply as possible.

Should the substance of muscle or nerve be lost, then we can only replace it by that which is still intact. A defect will always remain. We must therefore attempt to simplify conditions so as to be able to get along with what is left (Lange).

From this we will see that we must make use of intact material in supplanting the paralyzed nerves as well as tendons.

The secondary deformities (positions from contractions) must be removed or even over-corrected before each operation (Hoffa) by weakening the antagonists (lengthening of the tendon), by shortening the overstretched tendons and ligaments, so that the newly-awakened function should find conditions of tension as nearly normal as possible.

Types of Paralyses.—We will now describe some types which lead to certain distinct deformities, without, however, expecting to be able even to mention most of the very large number of varieties.

If the focus of paralysis should be located in the root of the fifth or sixth cervical nerve, paralysis of those muscles would follow which are supplied by the upper branches of the brachial plexus. Paralysis of the deltoid muscle would be most noticeable (this lifts the arm up to the horizontal and presses the head into the socket). The arm hangs down flabbily, its weight stretching the capsule so that the head of the humerus is often several centimetres from the glenoid cavity (paralytic flaccid joint).

Should the sixth cervical nerve also be affected, we would find the muscles of the upper arm (biceps and triceps) paralyzed as well, and the elbow-joint could not be moved voluntarily.

In rarer cases we find isolated affections of part of the muscles of the forearm, *e.g.*, only those dependent upon the radial nerve, while the region of the median nerve remains intact.

Since, however, the single nerve trunks intermingle in the brachial plexus and take fibres for their muscles from the different segments, we can understand why paralyses in the hand are not found arranged according to the distribution of the nerves but according to segments. A grafting would have to be done high in the plexus in order to provide real new nerve conduction.

Should the disease have affected all the cervical segments we would then observe a complete paralysis of the arm.

A similar affection of the lumbar segments will make the leg hang down flabbily, the flaccid joints permitting every kind of motion (*"au polichinelle"*). When the pendulous leg is used to step, the gluteal muscles, being paralyzed, will permit the head to slip easily out of the acetabulum (paralytic dislocation of the hip).

As the knee, when its extensors are paralyzed, can only give some support by locking itself by maximal tension of the posterior ligaments every time it has to carry the weight of the body, a genu recurvatum (an over-extended knee) will easily develop.

The foot hangs down in equinus position and is slung down upon the ground so that it turns over inward quite easily (talipes equinovarus paralyticus).

All these deformities are the more pronounced in partial paralysis when the stronger antagonists contract in the direction of the deformity.

If only the psoas muscles should be intact, we would then observe a contraction of the hip in flexion; should the quadriceps be paralyzed and the flexors be intact, then the knee could not be actively extended (contraction in flexion in the knee). If only the muscles of the peroneal nerve should be paralyzed, then a paralytic talipes equinovarus would easily develop, from contraction of the muscles served by the tibial nerve. The opposite condition, the paralytic talipes varus, will be observed in paralysis of the supinators, also the paralytic talipes calcaneus after paralysis of the muscles of the tendo Achillis.

Treatment with Apparatus.—Orthopaedists have worked for some decades to produce apparatus to correct all these possible deformities. We attempt to restore the necessary firmness and motility to the limbs by enveloping them in supports which we join with splints, and apply hinges and elastic traction, so as to keep the weight off the paralyzed limb (see Apparatus for coxitis). In policlinical practice the celluloid-steel-wire splints are very serviceable (Lange); they are made similar to the flat-foot braces (*q. v.*) and are cheap and light, and can be made without the aid of the mechanic (see celluloid casts for fractures of the femur, Fig. 174b).

Only recently have we attempted by operations to free these unfortunates from their apparatus, which were unattainable for the poor owing to their original cost and the cost of repairs, and which were to the wealthy a constant source of worry and anxiety.

OPERATIVE TREATMENT

1. *Joints*

By eliminating the joints (resections) we change the infirm pendulous limb into a solid prop. Arthrodesis in the foot and the knee-joint transforms useless limbs into useful ones (Albert). But we must be careful not to sacrifice the epiphysis in the youthful bones, so that the leg, which anyhow remains backward in growth from non-use, is not shortened still further. As we usually have to work within the cartilage we cannot expect the same solid union as in adults, and in order to avoid secondary curvatures after arthrodesis, we either postpone this until later, or we let the patient wear fixation and supporting apparatus for a long time afterward. These will permit the use of weights and at the same time prevent curvatures (Jones). The putting on of the weight must be permitted as a preventive for atrophy.

We have thus frequently succeeded in paralyses of the lower limb in ridding the patient of his crutches and apparatus (Fig. 178b).

Even the latest writers (Vulpius, Bade) prefer arthrodesis to complicated and problematical tendon operations for the extensive paralyses in the lower limbs, and that justly, especially in those cases in which the weakened muscle or insufficient after-treatment and unintelligent surroundings would make the result doubtful. The nailing of the young bone (according to Bade-Lexer) is a real advance; in this method we stiffen the joints almost subcutaneously without opening them by driving in ivory pegs through the parts forming the joint.

Fig. 178a.

"Handwalker." Girl of seven years. All the muscles in both legs except the iliopsoas of each side are paralyzed. The child can get around only by crawling. Duration of paralysis five years.

2. *Operations on the Tendons and Muscles*

Nicoladoni taught us how to use the active muscles for the substitution of the paralyzed ones, and his method has been developed to a wonderful degree. Every paralysis was treated by tendon-grafting, and even when only one muscle was preserved it was split in two and thus made into its own antagonist, and we then expected a dissociation of the motions in the muscle itself. This polypragmasia naturally made the pendulum swing too much in the other direction—a consequence of abusing this excellent method.

We owe to Hoffa and others the working out of the methods now in use and their limitation.

The method of grafting now accepted is divided into the grafting of tendon upon tendon (Vulpius) and into forming a new insertion for

the muscle by sewing the tendon to the periosteum and bone (periosteal method, Lange). Each given case will tell us which method is preferable.

For instance, if we can unite the peripheral tendon of the tibialis muscle, which is paralyzed, with the fleshy part of the extensor digitorum, then we will naturally do it; but it is entirely different if we have extensive paralyses and little muscle preserved for a simple mechanism and we cannot make use of the points of insertion which had been serving for the finer complicated motions. In such a case careful consideration, clear mechanical understanding and wide experience will show us the way.

As far as possible only equifunctional muscles should be used for substitution, for when using the antagonists we can expect less of function than of muscular stability.

In the hands of the expert any one of the following methods can give the desired result and will supply us with unlimited resources: tendon-splitting, tendon-grafting, grafting the end of a paralyzed tendon upon a sound muscle, union of a less important sound muscle with the tendon of an indispensable muscle (Vulpius), periosteal fastening (Lange), lengthening by tenotomy or accordion tenoplasty, substitution of silk tendons, etc.

We will always have to pay special attention to obtain muscular equilibrium, though with lessened strength and simplified mechanism. Only thus will we be able to prevent the return of the deformity.

Fig. 178b.

Patient in Fig. 178a, one year later. The patient can walk a little in erect posture after arthrodesis in both knees. To prevent post-operative curvature she wears celluloid braces (for two years).

The after-treatment is one of the most important factors. Even when we form the new tendon we will have to consider the possibility of adhesions of the tendon to the neighboring tissues (interposition of fat). Careful early motions must aid in this. But we must avoid all overstretching of the muscle, because it can work only under a certain tension. After sufficient resistance to weight has developed, then we can permit the free use of the muscles.

In paralytic talipes varus as well as valgus we will be able to restore muscular equilibrium whenever sufficient sound muscle is left; otherwise we will have to prefer an arthrodesis (Vulpius).

In paralysis of the quadriceps we can get good extension either by using the tensor fasciæ with a long strip of the fascia, or with the sartorius (Schanz), or by pulling the flexors forward and sewing them on to the patella. Lange frequently uses in these cases, when the tendons are too short, a network of silk threads, which will later be covered by connective tissue and thus take the place of the tendon.

Fig. 180.

Fig. 179.

Fig. 179.—Paralysis of the left-sided abdominal muscles. Boy of nine years. Poliomyelitis six years before; also paralysis of the muscles of the right leg and paresis of the left quadriceps.
Fig. 180.—Muscle grafting in paralysis of the deltoid. Poliomyelitis three years before. Child of five years. The trapezius muscle and part of the pectoralis were sewed to the insertion of the deltoid. The picture shows the extent of function after one year.

Tenoplasty does not work very well in the hip-joint. Fortunately isolated paralyses in this region are rather rare. In extensive paralysis we will choose arthrodesis to prevent dislocation.

For paralysis of the abdominal muscles we recommend wearing an abdominal bandage (Fig. 179); this usually affects only parts of the muscles, because the nerve-supply is segmentary and comprises a number of segments. The nuclei for the iliopsoas muscle being near those for the oblique muscles, we will frequently observe paralysis of the iliopsoas accompanied by partial paresis of the abdominal wall.

In the upper limbs the conditions for tenoplasties are much more unfavorable; the most favorable is an isolated paralysis of the deltoid, which is a rather frequent form of paralysis (Fig. 180).

Extensive union of part of the sound trapezius muscle to the tendon of the paralyzed deltoid muscle with elevation of the arm may bring back the function of this muscle under careful after-treatment; the pectoralis muscle may also be used for this purpose. In one case we even succeeded by union of the deltoid with part of the pectoralis at the height of the shoulder not only in restoring the function of the deltoid but also the lost rounding of the shoulder (Fig. 180).

In the upper arm and forearm we will find it very difficult to restore the fine complicated motions by peripheral muscular grafting, and nerve-grafting will here prove far superior.

3. *Operations on the Nerves (Neuroplasty)*

Though some of the older surgeons had reported good results from neuroplasties, it is only recently that they have again been competing with other methods of conservative surgery.

It has been proved conclusively by animal experiments that we can succeed in supplying two peripheral nerve-ends with sufficient innervation from one central nerve-end. This we can do in either of two ways, either by grafting the central stump of a sound nerve (all or only part of it) on to a paralyzed nerve (*central implantation*) or by introducing the peripheral stump of a paralyzed nerve into the course of a sound one (*peripheral implantation*). Modifications of this are possible in which the whole central stump of a less important nerve is united with the peripheral end of an important one in order to supply it with new nerve-impulses. It depends upon the case in hand which of these methods should be used.

We, personally, can look back upon a considerable number of successes with this method, and we feel, therefore, that we are entitled to recommend it, for others also report successes in steadily increasing numbers.

In one case of paralysis of the radial nerve, caused by intra-partum fracture of the neck of the humerus, we succeeded in getting a perfect cure, after it had existed for twelve years, by a partial central implantation of the median nerve, inside of eight months (Figs. 181a, 181b).

Several cases of poliomyelitic paralyses of the peroneus and axillaris nerves showed recovery or at least improved function (Fig. 182).

For some reason which we can not yet explain the neurotization of some of the muscles in the united groups may fail, but this can later be mended by tenoplasty.

Fig. 181a   Fig. 181b.

FIG. 181a —Paralysis of the radial nerve from birth-injury. Boy of twelve years. Operation: partial central implantation of the median nerve into the radial nerve.

FIG. 181b —Same case five years later. Hand and fingers can be extended, the thumb can be abducted, and the forearm supinated.

Fig. 182

Paralysis of the peroneus cured by neuroplasty (partial central implantation from the tibial nerve into the peroneus nerve). Girl of five years. One year after operation

The first principle, and one which we must always adhere to, is *nil nocere*. We must never risk any of the sound material, and careful technic will avoid permanent postoperative defects.

This treatment, which attacks the paralysis more centrally and which restores even complicated motions, is without doubt a great advance in the treatment of paralysis. As mentioned before, we must not wait until the muscle is entirely dead. When the muscle has been failing for some months we should proceed with the neuroplasty. Spontaneous regeneration would take place in the course of the first six months at least by traces of contractions or by the persistence of the quantity and the quality of electrical irritability. (We must caution against over-stretching of the muscle.)

We can expect the appearance of the first motion about three months after the operation. The voluntary impulse will appear first and the electrical reaction later.

In *peripheral paralyses after injuries, fractures, etc.,* we consider principally the primary and secondary neurorrhaphy, which will give excellent results even after some years. The nerve, if enveloped in callus and scar-tissue, must first be freed (neurolysis). Should it be severed in its continuity so that its union is impossible, we will have to try first a "suture à distance" (Vanlair, Vulpian), and then its grafting upon the area of a sound nerve. When this also fails, we can resort to tenoplastics.

The paralyses of the plexus of the upper extremity (birth-palsies) occupy a special position. A lesion of the cervical roots during labor may cause a paralysis of the upper roots (type of Duchenne-Erb) as well as that of the lower roots together with the sympathetic branch (Klumpke). According to the investigations of Kennedy, which we can verify from six operated cases, we frequently find a crushing of the roots and the interposition of scar-tissue which renders the interruption of the current a permanent one. The first union of the fifth and sixth roots, the origin of the supraspinatus nerve, is exposed to injury most frequently in different positions of the arm, owing to its location between the first rib, clavicle, and transverse processes of the vertebræ; this is the reason why these types of paralysis are so numerous. Kennedy, as well as the author, was able to get a restitution of function after several months by resection of the scar-tissue.

In one case, of a girl of six years, we were unable to find the supraspinatus nerve, which arises at this typical location, as it had been destroyed during birth. In this, as well as in another case, we succeeded in removing the interfering contraction by an osteotomy below the surgical neck and then rotating the humerus outwards, and thus improved the function of the arm (Figs. 183a, 183b).

Fig. 183a.

Paralysis of the outward rotation from birth-injury. Elevation of the left arm possible only to the position given in the picture. Girl of five years.

Fig. 183b.

Restoration of function by osteotomy below the surgical neck and twisting the lower fragment. One year after operation

Overstretching the fibres without any macroscopic scar-tissue may also lead to interruption of the current, and we will then observe that the sensitive fibres are the more resistant (see Compression of the spine, Spondylitis).

A boy of five years was tied by his brother to the horn of a cow with a rope around the right wrist and was thus dragged quite a distance. Without any visible external injuries the arm was paralyzed. On cutting down upon the plexus and following it to the foramina vertebrarum we were not able to find any macroscopic change in the roots. The electrical irritability was gone. Sensibility was not entirely abolished.

Similar conditions were observed in an operated case of birth-palsy. But usually we will find the above described scar-tissue, which we resect, reunite the stumps, and get good results. When no scar is present, then we will, when the case presents itself for an early operation, provide reinnervation of the nerve from a sound trunk (partial central implantation); in older cases we will do a total peripheral implantation of the paralyzed trunks into the sound ones after careful analysis of the paralysis.

B. SPASTIC PARALYSES

The spastic contractions of the muscles which we call spastic pareses are observed either as parts of cerebral processes (birth injury, encephalitis), or more rarely from spinal or meningitic diseases. In reality the affected muscles are in a state of hypertonus.

The investigations of Förster have brought new light to this subject. The higher centres in the cortex which act in regulating and inhibiting muscular action are almost always affected. They are either damaged by inflammatory or degenerative processes in the brain, or their nerve current interrupted by cross lesions. The muscles are in a continuous state of reflex irritability which comes from the sensitive surface, and in this we will find the atavistic older functions to prevail considerably. The flexors of the hip and knee, the adductors of the leg, the muscles of the tendo Achillis, the pronators and flexors of the arm, the grasping muscles of the hand, all these are in almost continuous permanent tonic contraction which offers a rigid elastic resistance to active as well as passive action of their antagonists (Fig. 184).

Förster has shown that in spastic patients the long-continued posture alone will produce permanent contractions in that muscle which is shortened by the position (approaching of the points of insertion), so that the phylogenetic preponderance of some of the muscles may be increased by the position of the child in utero.

To remove these permanent contractions Förster advises a treatment which consists in the resection of the sensitive part of the reflex arc. Anatomical investigation shows that total sensitive paralysis of

a segment of the body arises only when three consecutive spinal seg-
ments are deprived of their sensitive roots. Förster has formulated the
law, "to make a choice of the sensitive roots of a limb in such a manner
that never more than two neighboring ones, and of two neighboring ones
preferably only one should be resected." Thus he resects in Little's dis-
ease the second, third, and fifth lumbar and the second sacral root. By

cutting through single posterior
roots of the lumbar nerves, before
they join the anterior ones, he
prevents the occurrence of sensi-
tive irritation and thus stops the
reflex spasm.

Though this is a major opera-
tion owing to the opening of the
spinal canal, yet it is indicated
in severe spastic cases and gives
excellent results. In less severe
cases, especially of the lower
limbs, by weakening the stronger
groups of muscles, lengthening
the tendons by tenotomies (tendo
Achillis, gastrocnemic), and les-
sening the adductors by myoto-
mies, we can succeed in restoring
muscular equilibrium. Posture
in overcorrection will give the
muscles which had been dam-
aged by hyperextension a chance
to contract. Gymnastic exer-
cises will teach these muscles
their proper amount of work,
which is now possible after their
antagonists have been weakened.

In the lower extremities these
simple operations will suffice. In
the upper extremities we will get
good results from neuroplastics,

Fig. 184.

Little's disease (spastic paresis). Boy of six and one-
half years. Considerable contraction in adduction, talipes
equinus. Treatment: tenotomies of the adductors and
the Achilles tendons, plaster cast in over-corrected posi-
tion for three weeks, then walking exercises for several
months.

especially in those cases in which we have to deal not so much with a
general weakening of the motor strength, as with the prevalence of
certain groups of muscles.

The most annoying symptom is the continuous pronation of the
hand—the so-called obstetrician's hand (flexion of hand and fingers,
adduction of thumb) (Fig. 186). This is shown by neurological analysis

Fig. 185b.

Fig. 185a.

FIG. 185a.—Spastic hemiparesis. Child of three years. The right forearm is in rigid pronation, the thumb is drawn in, hand and fingers flexed at the same time.

FIG. 185b.—One year after operation (partial central implantation o. the median nerve into the radial nerve, tenotomy of the adductor pollicis muscle). Supination is free, also extension of hand and abduction of thumb.

Fig. 186a.

Spastic hemiparesis. With typical position of hand (see Fig. 185a).

to be the overaction of the muscles supplied by the median nerve over those supplied by the radial nerve, and that this condition is only less clear owing to the action of some of the muscles innervated by the ulnar nerve. Plastic operations on the median nerve and the radial nerve (Spitzy) will generally succeed in restoring the function.

We split off a central part of the median nerve from above the branch going to the pronator teres muscle, using this branch as a landmark; this we implant into the radial nerve, thus weakening the hyperactivity of the median nerve and at the same time strengthening the conduction to the radial nerve. This will be shown by the muscular equilibrium in the motions after regeneration has occurred, *i.e.*, after

Fig. 186b.

One year after operation. (Same as in Fig. 185b.)

three or four months. Some spastic muscles which are innervated by the ulnar nerve—as, for instance, the adductor pollicis—can be weakened or shortened by myotomies (Figs. 185b, 186b).

With these operative measures, which are assisted by bandages and apparatus, we will be able to overcome all the spastic affections, parapareses and hemipareses, though all these therapeutic measures will only succeed provided the intellectual faculties of the child are undisturbed.

Should the psychic centres and their branches be also affected, then no kind of operation or apparatus will produce any results of any account, because the gymnastic treatment, which is always important and necessary, cannot be instituted.

SECTION VI

TUMORS

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Of the many kinds of tumors only a very small number are of interest to the pediatrician. Some of these which we have to regard as congenital (lymphangiomata, dermoid cysts, sacral tumors) have either been described or at least mentioned under the congenital diseases.

A. CONNECTIVE TISSUE TUMORS

1. Hæmangioma

Hæmangiomata are the most frequent forms of tumors found in children. They are made up of blood-vessels in irregular construction, and they arise and grow by new-formation and exuberance of the vessels.

Etiology and Pathologic Anatomy.—Lexer divides these into hæmangioma simplex, angioma cavernosum, and angioma racemosum.

The *hæmangioma simplex* lies in the skin, and is usually formed by a convolution of capillaries. It is sometimes separated from the surrounding tissues as by a membrane, but much more frequently it sends out sprouts in all directions, which burrow into the tissues, destroying them, and spreads rather rapidly with malignant tendencies.

Ribbert believes their origin is due to disturbances of development. A small, circumscribed capillary region with its own artery and vein develops independently, without its being kept back by the tension in the tissues surrounding it. We frequently observe them near original clefts—near the mouth or the eyebrows (combination with other congenital anomalies).

When they are confined to the skin, they form the well-known "strawberry-marks." As long as these are on the level with the skin they will only deserve cosmetic consideration. As soon, however, as they grow above the level of the skin, or send their lobes into the deeper tissues, then they begin to assume a malignant character.

When they are only in the subcutaneous connective tissue, without attacking the skin, they will form bluish, soft and easily expressed

tumors which show underneath the skin and come nearer to the second type—that of the angioma cavernosum.

The *angioma cavernosum* contains cavities which are filled with blood, in which thrombosis and calcification are of frequent occurrence. Their most frequent location is on the cheek, on the scalp, and on the ear (Fig. 187).

In the tongue they may cause a form of macroglossia (see Congenital Diseases of the Face, p. 36).

On the forehead they sometimes appear under the skin as convolutions of veins, which form shallow excavations in the skull by their pressure which can be felt through the thin skin.

In excitement these formations swell the same as natural corpora cavernosa (tumeur érectile, Fröhlich).

The arterial *racemose angiomata* are much rarer. These are recognized by the convoluted, frequently dilated arteries which stand out like corkscrews and pulsate. These are especially malignant owing to their unlimited growth.

Angiomata may also be observed in muscles (long dorsal muscles), where they spread rapidly by the formation of sprouts and nests (muscle-angiomata).

The course of angiomata differs a great deal, from the benign strawberry-marks to the malignant spreading cavernous and racemose angiomata and their combination with sarcomatous formations, and we cannot draw a sharp line between the different phases.

Every angioma may at times grow and become malignant. We can only speak of a spontaneous cure in so far as infection of angiomata may easily arise from injury of the thin surface and then suppuration sets in, so that the consequent formation of scars will compress the angioma; usually, however, some portions are left over, from which the angioma may redevelop.

The **symptoms** of angiomata depend entirely upon their location.

The **diagnosis** can be made at once from the color and shape, which are superficial and include the skin. Cavernous angiomata may be emptied of their blood by pressure, but will refill at once to their former size as soon as we release the pressure.

In deep angiomata their differentiation from lipomata may be difficult (bluish and shining appearance of the skin, compressibility). The racemose angioma is so characteristic in appearance (pulsation) that it can easily be discerned from the superficially similar neuroma plexiforme.

The **treatment** of angiomata must be as radical as possible. It is best to circumcise the tumor within the healthy tissues, on account of their occasional malignity.

Bleeding will be inconsiderable when excision is done rapidly and with the proper digital compression, especially if we avoid cutting into the angiomatous tissue itself. Larger vessels are ligated and sutures are placed in such a manner that they will include the bottom of the wound; thus we will best prevent the formation of hæmatomata and possible hemorrhage.

Puncture with the Paquelin cautery or the electrolytic needle is used only in parts of the body where the shorter and more radical total excision is impossible (edge of lid, lobe of ear). Puncture and electrolysis both permit a more conservative procedure and a saving of more of the supporting tissue (cartilage); but this treatment is slow, the scars are extensive and their size cannot be predicted.

Sauerbruch reports success from the treatment of angiomata with liquid carbon dioxide. Carbonic acid snow, which develops when we allow liquid carbon dioxide to escape from the tank, is placed upon the surface of the angioma and left there for from ten to twenty seconds. This is repeated a few times with intervals of from eight to ten days, and the angioma disappears "without leaving any scar" and without causing any pain.

Fig. 187.

Multiple hæmangiomata of the face of the cavernous type. Child of three months.

[This treatment originated with the late Dr. A. Campbell White, of New York, who in 1899 published an article in the *Medical Record*, "Liquid air: Its application in medicine and surgery." At the meeting of the Sixth International Congress for Dermatology in New York, 1907, Dr. W. A. Pusey, of Chicago, told of his success with carbonic acid snow. —THE TRANSLATOR.]

In angiomata covering a large surface (for instance, on the skull) it is preferable to operate in several sessions. We first excise an elliptical piece from the middle of the angioma, catch the edges quickly under compression and unite them. By repeating this two or three times we succeed in removing angiomata, the removal of which at one time would have left defects which it would have been hard to close.

Inoperable angiomata of the face and those which spread over a large surface and go very deep, and which therefore can not be operated upon, may be made to disappear by sticking arrows made of magnesium into the tumor, according to Payr. The arrows are inserted in all direc-

tions through a small incision in the skin; absorption of tne metal causes coagulation, dissolution, and scar formation, and thus disappearance of the angiomatous tissue.

In some cases the application of the Röntgen rays, and in others the emanations of radium, have given splendid results in operable angiomata. In one case of angiomatous degeneration of the whole of one upper lip the application of radium for some months produced a permanent cure without any extensive scar.

The injection of alcohol and other irritating liquids was formerly highly recommended to abolish these tumors, but it may cause necrosis and disagreeable symptoms (thrombosis, suppuration) and it is therefore better to regard this as an obsolete method of the preantiseptic era.

2. *Lymphangioma*

The structure of lymphangioma is similar to that of hæmangioma, and consists of the dilated lymph-vessels. It is usually classified as

FIG. 188.

Lymphangioma cysticum (somewhat shrunken in the preserving fluid), originating from the root of the mesentery of a child of one year

lymphangioma cavernosum and lymphangioma cysticum, according to whether the cavities intercommunicate and are in open connection with the lymph-channels and may be emptied into them by pressure, or form closed cysts arranged in the shape of grapes.

The favorite sites of the cavernous lymphangiomata are the tongue, cheek, ear, back of knee, axilla.

The prevalent type of the cystic lymphangioma has already been described under the congenital diseases as hygroma colli cysticum (p. 39).

The cystic lymphangioma may also at times be found in other localities (upper arm, axilla, back of knee).

We observed a large multilocular cystic lymphangioma in a child of one year on the root of the mesentery, which filled the entire abdominal cavity, and owing to the twisted pedicle of one cyst it simulated peritonitis. The whole tumor looked like a grape and was attached to the mesentery by a thin pedicle. After operation the child remained free from recurrence (Fig. 188).

The lymphangiomata are also regarded as caused by a faulty predisposition, and this is made more probable by their frequent congenital appearance. They are more malignant than the angiomata, and therefore their radical removal is obligatory (see Hygroma colli cysticum).

GANGLIA

Similar symptoms, though their etiology and structure are entirely different, are caused by cystic tumors which are observed in different parts of the body, near joints and tendon-sheaths, and are formed by the tying off and sacculation of the joint-capsule or tendon-sheath, and are called "*ganglia*."

They are most frequently found on the back of the hand, near the joints of the foot, occasionally also at the back of the knee-joint near the large flexor tendons.

The wall of these cysts shows the structure of the capsule or the tendon-sheath, with which the ganglion may still be united, either communicating with the joint or tendon-sheath by a duct, or this duct may have become impervious and the strangulated part have developed as an independent cyst. Its growth is slow and the symptoms depend upon the location of the swelling. The skin is always movable over the cyst, which feels firmer than a lymph-cyst, is not pervious to light; its contents are thicker, jelly-like, the cyst is filled tightly and is hard.

The treatment consists in extirpation, and when doing this we must always remember that it may communicate with the joint-cavity (easily infected). Before deciding on an operation we may try to break the cyst subcutaneously, and in a large percentage it will not recur (Lexer).

3. *Sarcoma*

Pathologic Anatomy. — These connective-tissue tumors are very malignant and, owing to their rapid growth, they are mostly formed of young, undeveloped, and undifferentiated cells. They may arise from

all the different kinds of connective tissue of the body and will show their respective structures, though the exceedingly rapid growth will make them lose their peculiar structure and they will look more and more like embryonal connective tissue.

Their malignancy is based upon the exuberant growth, by which they push aside, pervade, supplant, and choke all other tissue.

On account of their deficiency in blood-vessels, they break down easily and become necrotic. Cells which have grown into the blood-channel become separated and are carried on, and these have the faculty to grow in other localities and to produce metastases. We can easily understand that their close relationship to embryonal structures makes these tumors relatively frequent in the growing body of the child. We even observe, and by no means rarely, *congenital sarcomata* in children.

The skin, the bones, and the glandular organs are the favorite sites of sarcomata in children.

The *sarcoma of the bone* is the one most frequently observed, from the relatively benign giant-cell sarcomata originating from the periosteum of the jaws (epulis) to the malignant soft spindle-cell sarcomata of the joints.

We differentiate two types according to their origin: the periosteal and the myelogenous.

The *periosteal type* begins as circumscribed tumors of the bone which are covered by a thin layer of periosteum, most frequently near the metaphysis (Lexer). At first they can be separated from the bone, but soon they attack this as well and then spread rapidly to the inside of the bone and also into the surrounding soft parts (Fig. 189, Plate 21).

The *myelogenous type* starts from the bone-marrow, and we observe this most frequently close to the cartilaginous border in the spongiosa, whence it fills the bone gradually (Figs. 190, 191).

The bone is distended and thinned from the inside. The tumor itself may break down on its interior, thus causing the formation of cavities and bony cysts. In the benign giant-cell osteosarcoma this stage may persist for a long time (spontaneous fracture), though the tumor may at any time resume its tendency to rapid growth and may cause the death of the patient from the formation of metastases in the internal organs.

The Diagnosis. —The recognition of osteosarcomata can be difficult only in the very beginning. Osteomyelitic processes will give the same appearance externally as well as skiagraphically, but the inflammatory character of the osteomyelitic process, with its redness, suppuration, fever, and pain, will show us the difference.

The *differential diagnosis* from gummata or fibrous cysts in the bones will be much more difficult. The rapid course and skiagraphy will be

invaluable. Finally an exploratory excision will be decisive, and with this we must not hesitate, as rapidly growing tumors demand instant removal, while our waiting for the result of an anti-syphilitic treatment may cost us too much valuable time.

The **prognosis** of these bone-tumors is always unfavorable, except that of the above-mentioned epulis. The most extensive resections within the healthy tissues and amputations may occasionally save a life.

Fig. 190.

Myelogenous sarcoma of the tibia of a child of three and one-half years. Treatment: amputation (death from metastases after six months). Histologic diagnosis: spindle-cell sarcoma.

The lymph-glands may become sarcomatous by metastasis, but they may also be themselves the starting point of lymphatic growths.

The *lymphosarcomata* with a structure similar to lymphocytes are occasionally observed in children, originating from the lymph-glands near the digestive tract or the neck. They grow rapidly and form massive tumors, which grow into the surrounding organs, destroying them.

The differential diagnosis from other similar diseases must be made by observing the course of the disease, aided by the examination of the blood and the blood-forming organs (see Japha, Diseases of the Blood, vol. ii)

The malignant lymphosarcomata also consist of new formation and growth of the lymph-glands; they do not, however, break through their capsule. The single tumors in the neck remain separate, but gradually the whole lymphatic apparatus of the body is affected.

The pseudoleukæmic tumors are recognized by the exuberant growth of the neighboring lymphatic glands, beginning usually in the neck. The glands are easily felt through the skin, and can be moved against each other and show no tendency to break down or to suppurate.

Fig. 191.   Fig. 193.

Fig. 191.—Inoperable sarcoma of the upper maxilla in a child of two years, of five months' duration. The tumor grew rapidly during the one month in the hospital. It perforated into the mouth and was ulcerated upon its surface; death from pneumonia. Histologic diagnosis showed round-cell sarcoma.
Fig. 193.—Soft fibroma on the ear of a child of three years. Congenital, growing slowly.

The intestine may also be the seat of sarcomata, which start from the connective-tissue structure of the intestine, and when the unstriated muscle fibres multiply we will have mixed tumors of sarcomata and leiomyomata (Figs. 192a, 192b, Plate 21).

In a boy of five years we removed from the ileocæcal valve a tumor the size of a fist by resecting the cæcum and the end of the ileum which was invaginated together with the tumor (see Invagination).

The microscope showed the above-mentioned type of mixed tumor, made up of muscle cells and spindle cells. After three months of apparent health metastases appeared in the skin and the pleura, causing death.

The kidney is also at times the seat of sarcomata, which are then frequently of congenital origin, also the bladder and the testicles, but these tumors are rarities (see Epithelial Tumors).

PLATE 21.

FIG. 189.—Periosteal sarcoma at the upper end of the humerus, of three months' duration, in a boy of three years. Treatment, enucleation, permanent cure. Histologic diagnosis, myxosarcoma.

FIG. 192a.

FIG. 192b.

Leiomyosarcoma of the ileocæcal valve of a child of four years. The enlarged hard cæcum (Fig. 192a) contains in its interior an invaginated piece of small intestine which is prolapsed through the ileocæcal valve; this has been still further invaginated by the traction of the growing sarcoma, and has thus prolapsed into the cæcum Fig. 192b shows the prolapsed sarcoma after inversion of the cæcum Treatment, resection. End-to-side anastomosis between ileum and ascending colon Histologic diagnosis, spindle-cell sarcoma with considerable intermixture of unstriated muscle-cells. Death three months later from metastases (pleura, intestine, liver).

The treatment must attempt the earliest and most radical removal. The limits of our ability to operate are formed by the anatomical conditions, adhesions, glandular metastases, and the power of resistance of the patient. The technic follows the generally accepted principles of surgery, considering, however, the somatic particularities of the child.

In conformity with its connective-tissue type the sarcoma inclines toward mixed forms combined with other tumors which are also of mesodermal origin. The benign connective-tissue tumors, like fibromata and myxomata, may also be mixed with sarcomatous tissue or be transformed into this through a sudden tendency to grow (*fibrosarcoma*).

These tumors, which are rare in childhood, are of some importance as far as our treatment is concerned, because they should be removed as soon as possible owing to their tendency to grow exuberantly at times.

The fibroma of the nasopharynx, which is of special diagnostic importance (Kümmel), is usually observed later — between fifteen and twenty years of age.

Fig. 194.

Lipoma in the right labium in a child of ten years.

4. *Lipoma*

This is not frequent in childhood. The lipomata consist of fatty tissue and favor advanced years. On the shoulder or the back are they mostly found. One case of familiar appearance of lipomata was interesting. The mother had multiple lipomata and her history indicated that she died most likely from their sarcomatous degeneration. One of her two girls had a lipoma on the back, the other a large lipoma of the labium majus, which looked like a hernia with adhesion of the omentum (Fig. 194).

5. *Chondroma*

The degenerative growth of the cartilage more often affects the young. It is usually located in the phalanges or in the metaphyses of the long tubular bones, where it will cause interference with the growth of the bones either by affecting the bone itself or its zone of growth

(Ollier's disturbance of growth). The frequently mentioned *bony cysts* also partially belong here. Cystic degeneration of chondromata of the tubular bones may lead to the formation of bony cysts (Lexer), though these may also start from softening of parts of the bones and inflammatory softening from the bone-marrow. Osteomalacic conditions are also of some importance (v. Haberer).

6. *Osteoma*

This is frequently mixed with cartilaginous tissue (cartilaginous exostoses) and is by no means rarely found near the epiphyseal lines.

The treatment of all these benign connective-tissue tumors can only be operative, and this is the more urgent if they show a more rapid growth, thus justifying us in our suspicion of their malignancy.

7. *Glioma*

Of the neuromatous tumors in children we observe the glioma, especially that of the eye, starting from the neural elements in the retina (according to Ribbert they are congenital) (Fig. 195).

Fig. 195.

Glioma in a child of three years.

B. EPITHELIAL TUMORS

1. *Adenomata*

The adenomata are the most important epithelial tumors in childhood. They are benign polypoid tumors which consist mostly of loose connective tissue. Their surface is smooth and the submucosa and muscular tissue take part in the tumor formation (Lexer). Besides the adenomata of the nasal mucous membranes we observe most frequently rectal polypi (polypositas recti).

Pathologic Anatomy.—They usually adhere to the sacral wall of the rectum near the anus as tumors from the size of a pea to that of a cherry. At first they have a broad base, but by the movements of the gut and the passage of the stools this is soon drawn out to a long pedicle, which

will often even permit the velvety red round polypus to appear outside
the anus during defecation. The structure of these polypi is almost
always that of the true adenomata of the mucous membranes; rarely
we find a fibrous admixture or base in children. According to their
structure, they are tender, soft, and easily injured, with rich vasculariza-
tion, which explains the bleeding.

The polypi prefer the sacral wall of the rectum, where they are fre-
quently found in numbers. In the ampulla especially they may be found
in clusters, their size varying from that of a grain of rice to that of a
cherry and even larger. Closely related, histologically, are those cases
in which the whole large intestine contains polypi (Schneider). But we
must not confound these with angiomatous plaques, which latter are
also found in the ampulla and are closer to the hemorrhoidal tissue.

According to Piéchaud heredity plays some rôle in this condition.

Symptoms. — These usually appear only when the single tumors
have grown to some size; usually more or less copious bleeding with
defecation will send the parents to the physician.

There is increased straining caused by feeling something like a foreign
body near the anus, which is intensified by the frequent injury to these
small tumors, with hemorrhage, also pain from pulling on and irritation of
the rectal wall. Furthermore are those difficulties with urination to be
mentioned which we observe in all painful affections in and around the
rectum, called by the French *ténesme vesical*, and which we can easily
understand from the close nervous and embryological relation between
bladder and rectum. Every action of the sphincters is avoided, as these
will rarely act separately owing to their anatomical position. This reflex
retention may assume excessive degrees, so as to cause a suspicion even of
severe affections in the genito-urinary system (see Pararectal Abscesses).

Diagnosis. — This is usually easy. Bleeding from the rectum in the
absence of a prolapsus or of a larger fissure or of (though in children we
need hardly consider this) hemorrhoidal nodes, must make us think of
polypi, which can frequently appear during defecation. Otherwise the
examining finger can feel these on the sacral part of the rectum and a
speculum will make inspection easy (Fig. 196).

Treatment. — Steady lengthening of the pedicle and its tearing
through is a form of self-cure, but the disagreeable symptoms will soon
demand an early removal of the source of the hemorrhage. We should
avoid pulling on the polypus, as its tissue is very friable and it may reform
from parts which are left behind.

After cleansing the ampulla we expose the polypus freely and ligate
the pedicle as near as possible to the mucous membrane and then cut
off the tumor. Polypi with a broad base should be circumcised and the
mucous membrane carefully sewed up, on account of the danger of an

infection of the pararectal tissues from the rectum. Before the operation we thoroughly clean out the bowels, and afterward give small doses of opium and a constipating diet, thus saving ourselves from having to pack the rectum, which is very disagreeable and not advisable in children on account of the continuous pressing.

Tumors situated higher up can be brought into view with the rectoscope. In extensive polypositas with numerous millet-seed tumors we

Fig. 196.

Rectal polypus.

have found douches with alum (5 per cent.) very effective to stop the bleeding. Against the extensive polyposis intestinalis our treatment is quite powerless (Schneider).

2. *Cysts of the Epithelial Structures*

These are most frequently observed as *dermoid cysts* (see Congenital Affections). Cysts of the embryonal clefts and ducts have also been described (see Branchial Cysts).

Cystic dilatation of the pelvis of the kidney with compression of the parenchyma (*hydronephrosis*) also belongs here. For the symptomatology of hydronephrosis and cystic kidney see Langstein, vol. iv. For the extirpation we employ the same technic as for nephrectomy.

Retention cysts of the glands are met with as *atheromata,* and they are caused by occlusion of the sebaceous glands or their ducts. It is not always easy to diagnose these from dermoid cysts. The typical location of these latter at the edge of the orbit near the primordial clefts makes their nature clear. Atheromata are frequently adherent to the skin, while this is usually movable over dermoids. At times we can make a diagnosis only with the microscope. The epithelial lining of the atheromata does not contain any papillæ, while the capsule of the dermoid cysts contains all the parts of the skin.

Treatment consists in total removal of the bag, because remnants of this may give rise to recurrences.

Retention Cysts of the Mucous Glands.—These are best known as *ranula,* and are found in the mouth underneath the tongue. Here they are usually formed through occlusion of the duct of the sublingual glands, more rarely through the occlusion of mucous glands. They appear as thin-walled translucent cysts of slow growth which may lift up the tongue. Their content consists of a clear sticky liquid.

Treatment has to consist in their radical extirpation. Should this be impossible, then we remove the anterior wall and sew the posterior wall to the mucous membrane, thus preventing new formation of the cyst. No other mode of treatment will prevent recurrences.

3. *Carcinoma*

This type of tumor is rare in children.

They are seen most frequently as cancer of the kidney, and Karewsky claims that childhood is predisposed to this to some extent.

Usually we observe mixed tumors of the kidney, embryonal

Fig. 197.

Mixed tumor of the kidney in a child of eighteen months. The tumor fills almost the entire abdomen. Considerable congestion (notice veins in the abdominal skin). Post-mortem diagnosis: mixed tumor of the kidney (embryonal glandular sarcoma).

glandular tumors, which it is difficult to arrange in any one group of tumors (Döderlein, Birch-Hirschfeld) (Fig. 197).

They are observed almost exclusively in children and then only during the first few years of life. They grow very rapidly and can be recognized quite early as large tumors which we can feel through the

abdominal wall. The results of their extirpation are bad, because the children are brought to the surgeon only when the neoplasm is too large to be removed. According to Bruns the mortality is 30 per cent., and about 10 per cent. were well for one year after the operation.

Closely related to these tumors are those mixed tumors which develop at the pelvic end of the embryonal structure, and are there known as teratoid mixed tumors or as *teratomata*. These "sacral tumors" may be formed of the three germinal layers and may grow through bones and soft parts like malignant tumors, or they may remain cystic, and then grow to considerable size inside their cyst-wall either in the cavities of the body or on its surface.

In their interior they contain well-formed fetal rudiments of brain, bone, and even of extremities (*inclusio*), which latter have at times shown spontaneous motions.

SUPPLEMENT

Goitre

(See Siegert, Diseases of the Thyroid Gland, vol. iii.)

In certain localities where goitre is prevalent its excessive growth and especially the difficult respiration it causes may demand operative interference. As long as we have only to deal with a diffuse hypertrophy of the thyroid, the usual medicinal treatment with iodine ointment, potassium iodide internally, an ice cravat, and internal administration of thyroid gland, will have the desired result, especially in those cases of diffuse swelling of the thyroid gland at puberty.

In cases of partial hypertrophy, of the formation of nodules and cysts, which do not react so well to medicinal treatment, things will be different. In children the proper indication for operative interference is given by the dyspnœa. Disturbances of circulation, palpitation and arrhythmia are rarely observed in children.

Dyspnœa may be caused by displacement, compression, or surrounding of the trachea. Lateral or frontal flattening will arise especially in those cases in which part of the goitre reaches down behind the sternum, where it will find a resistance to further growth, and then narrow the lumen of the trachea, and even cause the trachea to atrophy from pressure.

This type, and the one in which the isthmus is drawn tightly over the trachea and in which at times an upper lobe which grows from the isthmus is grown onto the larynx or around this, are the ones which most frequently cause dyspnœa.

The **diagnosis** is easy, as movement of the tumor simultaneously with respiration characterizes it as a struma.

The displacement of the trachea may be shown by palpation or by skiagraphy after the introduction of a jointed intubation tube. Short exposures will clearly show the tube of the trachea against the surrounding soft parts.

When we cannot influence the dyspnœa by continued medicinal treatment, we will have to operate, as otherwise the life and the health of the child will be permanently threatened (thyroid asthma, thyroid death, heart affections).

The Operation.—This is no more difficult in children than in adults, as long as we do not use narcosis. In older children we can operate quite easily under local anæsthesia with $\frac{1}{2}$ of 1 per cent. novocain solution (injecting around the gland according to Hackenbruch).

Partial extirpation is done after Kocher's directions as follows: Transverse incision, intermuscular exposure of the gland, dislocation of the struma, ligation of the blood-vessels. We then make, after compression and separation of the isthmus, a frontal cut through the glandular tissue in such a manner that the posterior wall of the goitre together with the site of entrance of the ligated arteries

Fig. 198a.

Goitre. Boy of ten years. Nodular hypertrophy of the right lobe of the thyroid. Dyspnœa in walking, audible inspiration.

Fig. 198b.

Under local anæsthesia the right lobe of the thyroid was amputated, with preservation of its posterior wall. Operation brought on entire cure from all symptoms.

remains. The remaining capsule of the goitre is united with fine sutures. Thus we avoid extirpation of the epithelial bodies. By ligating the afferent blood-vessels we avoid hemorrhage.

Damaging the epithelial bodies by the ligature is less to be feared, because their embryonal origin is independent and without any con-

nection with the thyroid, and they have their own blood-supply. Before closing the skin incision we make a small incision immediately above the jugulum, through which we introduce a glass drainage tube into the wound. We thus aid the flow of the secretion, which is more considerable owing to the wide wound in the gland, without interfering with the healing of the large skin wound.

After the operation we fix the head and neck in starch bandage with wooden splints, to avoid the danger of late hemorrhage from the motions of lively children. The children are put to bed in a half-sitting posture; after forty-eight hours the drainage tube is removed and the child allowed out of bed.

FIG. 199.

Congenital goitre in an infant six weeks old. Hard tumor which can be moved very little and is continuous with the thyroid. The left lower jaw is deformed from the tumor, the mouth is crooked. Amputation of half of the thyroid brought on permanent cure. Histological diagnosis: congenital adenoma of the thyroid.

By avoiding narcosis we will almost always succeed in preventing pneumonia, which is always threatened, even in children, owing to the difficulty in expectorating and the suppression of this from pain.

A separate position is held by the *congenital goitre*.

This consists frequently of fetal adenomata (Fischer). In other cases we find a uniform hypertrophy of the gland which is often combined with hypertrophy of the thymus.

By bandaging the head back with an adhesive plaster strip from the forehead over the nape to the back (Langer), we are often able to lessen a severe dyspnœa.

Operation offers some hope. During the winter of 1907 we operated an infant six weeks old with a large struma and severe dyspnœa (Fig. 199). The operation was done without narcosis and the child stood it well. We did a one-sided extirpation of half of the thyroid together with the adenomatous tumor. In another case we only divided the protruding isthmus, which was easily done with an angiotribe and double ligation. Bleeding was inconsiderable and the dyspnœa was cured permanently.

Hyperplasia of the thymus may also cause symptoms of stenosis. We may be able to diagnose this with percussion or with skiagraphy. Rehn and König opened the mediastinum from the jugulum, and attempted to give relief by operative dislocation or extirpation of the gland, and they succeeded in two cases.

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Date Due